# NATURAL SCIENCE:

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## NOTES AND COMMENTS.

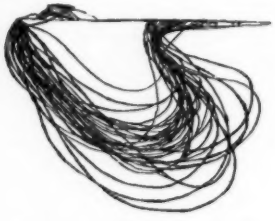
### Composite Generic Fundamenta.

THE *American Geologist* for April contains a note by Mr. J. M. Clarke, which is of such interest in connection with subjects lately discussed in our own pages, that we take the liberty of quoting it at length :—

"Some remarks on 'Mathematical Biology' in the February number of Natural Science, and the suggestion made by Bather in his recent work on the 'Crinoidea of Gotland,' that Galton's method of composite portraiture might be employed to ascertain a specific type from which variations in various degrees could be reckoned, recalled to me some germane experiments in which I was interested some eight years ago, and which indicate that there is even a possibility among narrowly restricted, up-to-date genera, of educing, by a series of comparative measurements and successive overlays, a sort of generic *fundamentum*. I take the liberty of citing and illustrating a single instance of this among the fossils, the case being a simple one and involving the search for the standard in one element of variation only, namely, *outline*; but whatever may be done with a single specific character, in this manner, is equally possible of all the others.

"In volume v., pt. 1, of the Palæontology of New York are described 57 species of the lamellibranch genus *Leptodesma*, two of which are ascribed to the horizon of the Hamilton group, and 55 to the fauna of the overlying Chemung beds. *Leptodesma* is an aviculoid genus with smooth and convex valves, and the shells upon which these observations are based are preserved plump and without disturbance of the marginal outline. The genus in some of the higher beds of the Chemung group is enormously prolific, so that the perception and identification of these 55 specific values is a puzzle to which the identification of Jurassic Ammonites or recent Unios is but play. Nevertheless, no more instructive series of variations of a single generic type has ever been described among

Palæozoic fossils. The first onset at such a group is certain to lay the student low with acute brain-fag, and leave upon his mind a hazy conviction that all the alleged species are pretty much one and the same thing. The beauty of the series and the persistence of its variations or species dawns upon the mind gradually but invincibly. Having attained this point in the study of the original specimens of these fossils, the attempt was made by the process of superposition to ascertain a standard or radicle outline for the entire generic group. In the making of this composite figure, which is here reproduced, it was, of course, necessary to fix upon two points or one dimension as a base to which all the elements could be reduced or elevated: just as in composite portraiture, the eyes, or some other indices, of all faces in the composite must be coincident. In this case the standard to which all have been made to conform has been the distance between the anterior cardinal extremity and the deepest posterior incurvature of the valve; a purely arbitrary dimension; probably any other would serve as well.



"The figure represents superposed outlines of the left valve of 36 of these species of *Leptodesma*. It will be observed that notable differences of outline in the components of this figure are obscured by the coincidence of the lines for a greater or less portion of their length, while the ruling outline or type stands out conspicuously like a coarsely shaded drawing of the valve. Of all the component outlines this interwoven valve approaches nearest to that of *L. rogersi*, as shown in the adjoining figure. It will naturally be understood that *L. rogersi* enters into this combination no more than the other 35 species, nor are there other shells whose outline is so nearly similar to that of *L. rogersi* as to produce a succession of parallel lines, which thus become intensified. The depth and predominance of the *L. rogersi* outline is wholly due to the coincidence of parts of outlines of species which vary greatly in this respect, as witness the four silhouettes of elements in this composition, shown on page 403.

"As already remarked, what is here done for the outline of the valves can be done with equal facility for convexity or other specific variations, either by this method of superposition or by the expression of such differences by a series of co-ordinates or mathematical curves.

"One interesting fact in regard to the type or *fundamentum* expressed in this composite is that *L. rogersi* (the silhouette of

which, here given, is of exaggerated size) is the temporal precursor of the cometary outburst of *Leptodesma* in the Chemung faunas, and is one of the two species occurring in the Hamilton faunas beneath.

"I am disposed to believe that whenever this method is practicable it will be found of real usefulness not only to biologists in general, but to the palæontologist in particular, especially in the determination of specific standards or *fundamenta*, as suggested by Bather. Its successful application implies, first of all, abundant data. With that prerequisite provided for, profitable comparisons could be instituted between species of distant faunas supposed to be identical, or which, though perhaps identical, may be masquerading under different names; and between such species in successive faunas of the same region. As a case in point, the brachiopod species *Athyris* or *Seminula subtilita* Hall would serve; an abundant and remarkably variable shell from the upper Carboniferous. In the lower Carboniferous limestones occurs an allied form, *A. subquadrata*, and it has been confidently asserted that neither species passes into the geological horizon of the other. Yet the two are greatly alike and each appears under many variations of outline and contour. Assuming that the two are alike in internal structure, which I believe to be essentially true, a series of composites might determine whether or not the variations of the two so-called species reduce to similar *fundamenta*, and if they do I should be inclined to regard this as rational evidence of specific identity. Again, the geological value of this method might be tested in such a case as that recently adduced by Professor Prosser, who argues that an extensive series of rocks in central and eastern New York, which appear to be permeated with Hamilton fossils, are not of the age of the Hamilton group, but represent a later geological stage, and that the fossils have, in a considerable degree, undergone modifications from their typical expression in the true Hamilton fauna. As the quality of these variations is hardly palpable under ordinary circumstances, and has not been satisfactorily expressed in words, it ought to appear in composites based upon sufficient data; and should there prove to be differences in the *fundamenta* of specific variations, from the true Hamilton fauna, and

of those from the alleged but contested Hamilton fauna above, the argument from such evidence would be entitled to serious consideration."

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### ORGANIC EQUILIBRIUM.

IN our last number, the review of Mr. Bateson's book on Variation gave occasion for some remarks on continuity and discontinuity in species. It will be remembered that the guiding idea of that book is that a species may change from one specific type to another by a sudden jump, or, as Mr. Bateson phrases it, by a discontinuous variation. In the words of Francis Galton, the species passes from one position of organic stability to another. It may therefore be interesting to remind our readers that similar ideas were long ago put forward by two American biologists, who, however, went even further in supposing a sudden passage of more than one species from one genus to another. E. D. Cope in 1868 discussed the Origin of Genera (*Proc. Acad. Nat. Sci. Philadelphia*), and showed, as he believed, that genera were grades of organisation, entered upon by more than one species at a time, and often entered upon with some suddenness. He explained these metamorphoses of species by a reference to metamorphoses or periods of rapid development in the life of individuals. When such periods corresponded with the period of reproduction, then the offspring would, he considered, be more liable to variation. When the metamorphosis of the individual was subsequent to reproduction, the offspring, and therefore the species, would remain unchanged; but when the metamorphosis occurred before the period of reproduction, the characters would be transmitted to the offspring, and the species would enter on a new phase. Cope compared these points of change to those critical points of temperature at which sudden changes take place in the molecular constitution of matter, and he applied to them the term "expression-points." Carefully examined, however, Cope's principle of "Acceleration" is seen to be essentially the same as what is now called the "Law of Earlier Inheritance"; and those who believe that the latter "Law" expresses the process of evolution of species and genera, certainly do not believe in any sudden change.

W. H. Dall, writing in the *American Naturalist* for March, 1877, similarly ascribes such supposed sudden changes "to the action of a law of development which finds expression in the paradox that the same species may belong to different genera." That sudden leaps may be due to the gradual accumulation of minute differences, he exemplifies as follows:—"In a sloping gutter of a paved street not too cleanly swept every one will have noticed on a sudden shower how small particles of earth and other materials will sometimes act as a dam, producing a puddle, which, relieved by partial draining, may for a time remain in *statu quo*. A time comes, however, when the gradually-accumulated pressure suddenly sweeps the dam before it

for a short distance, until another similar one is formed, the pool again appears for a time to remain unchanged, and so on indefinitely. Now the modern idea of a species may be stated to be a greater or lesser number of similar individual organisms in which for the time being the majority of characters are in a condition of more or less stable equilibrium, and which have the power to transmit these characters to their progeny with a tendency to maintain this equilibrium. This tendency may be, in some cases, sufficiently strong to resist for a considerable period the changes which a gradual modification of the environment may tend to bring about. When the latter has reached a pitch which renders the resistance no longer effectual, it is conceivable that a sudden change may take place in the arrangement of the constitution of the organism, adapting it once more to its surroundings, when the tendency to equilibrium may reassert itself in the minor characteristics, and they may, as it were, crystallise once more in a form not dissimilar in its specific results to that which was recognisable in the earlier generic type. If among a certain assemblage of individuals constituting a species, the tendency to maintain the specific equilibrium be (as it should be *à priori*) transmitted to the progeny in different degrees of intensity, a gradual separation might take place between those with a stronger tendency to equilibrium and those with less. Here natural selection would come in. Those yielding as above to the pressure of the environment would necessarily become better adapted to it (or perish) and with their changed generic structure might be able to persist. On the other hand, those with the broader base, so to speak, with the inherited tendency to remain unshaken by the modifications of the environment, may be conceived as through this tendency to be and to remain less injuriously affected by adverse circumstances, and consequently might still endure. In short, natural selection in the one case would find its fulcrum in the tendency to easy adjustment of characters; and in the other case in the inherited persistency in equilibrium rendering its possessor more or less indifferent to the injurious elements of the environment. The intermediate individuals by the hypothesis would be those least-fitted to persist in any case and hence liable to be rapidly eliminated. Then we should have parallel series of species in two or even more genera existing simultaneously."

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### Induced Variation.

How far the variation of organisms can or does take place in response to change of environment is one of those questions that the biologist is bound to answer before he can solve the problem of species. A determined attempt to answer this question has, we all know, been made for many years by Professor E. B. Poulton, in his experiments on caterpillars. At the Royal Society's conversazione, on

May 2, that investigator exhibited some living specimens of the larva of the Lappet-moth (*Gastropacha quercifolia*). Under usual conditions these caterpillars are of a rather dark brown colour, with a few whitish spots down the sides; some may be darker, and some lighter than the others. The specimens exhibited, however, which had all been reared from the same batch of eggs, had been divided into two lots, and, during the early stages of growth, one lot had been surrounded by black twigs, and the other lot by lichen-covered twigs, the food being the same in both cases. So impressionable were the youthful caterpillars, that all the former lot had become nearly black, with the white spots very few and small, while the latter lot were lighter than usual in colour and had the white spots large and numerous. Subsequent transference of a light caterpillar to the black twigs, or *vice versâ*, had had no effect upon its colouring; the response to environment took place only during infancy. In the course of a lantern demonstration, Mr. Poulton described many other experiments having similar results, and expressed his opinion that the young caterpillar did actually possess considerable sensibility and power of adaptation to the colour of its surroundings. This sounded like flat Lamarckism, but only for a moment. There was a limitation to be noted; there was no response to such colours as the caterpillar did not ordinarily come in contact with in a state of nature; or, if any effect was produced, it was only in the direction of some variation natural to the animal, and useful to it under certain natural circumstances. For this reason, and because all variations that do occur are clearly protective, the lecturer concluded that this marvellous power of individual adaptation to environment had been acquired through the ordinary processes of natural selection. And that is at all events sound Darwinism. Whether the experiments are yet sufficiently conclusive, will however be doubted by many entomologists.

A most interesting example of this individual adaptation, regularly occurring amid natural surroundings, has recently been added to the beautiful series exhibited in the central hall at the British Museum (Natural History). In the forest of Maramanga, which is in Madagascar, about 65 miles east of Antananarivo, there lives a Homopterous insect, which men (scientific men) call *Flatoides dealbatus*. When this insect settles, as is its habit, on the bark of the forest trees, it becomes almost imperceptible; for each specimen, though differing slightly from its neighbour, bears, when its wings are closed, a most striking resemblance either to plain bark, or to bark covered with green moss or grey lichen. This, as the Museum label with true scientific caution expresses it, is "a fact which seems well calculated to afford them protection." Madagascar has also furnished the Museum with the curious beetle, *Lithinus nigrocristatus*, whose black and white or yellowish colour and black hairs render it almost indistinguishable from the lichen-covered twigs among which it lives.

Some sceptics say that birds must be very foolish creatures to be deceived by certain so-called protective resemblance; but the birds in Madagascar must be very old birds indeed if they often get a meal off either of these marvellous examples of mimicry.

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### The Ways of the White Ant.

An example of individual adaptation of somewhat different nature was also to be seen at the *soirée* of the Royal Society, in the case of Termite ants exhibited by Dr. D. Sharp. We have already alluded to the recent work of Grassi and Sandias on the two European species of this family (Natural Science, vol. iv., p. 312), a work that has stimulated afresh our curiosity as to the social economy and the physiology of the white ants. As has been partly explained by Dr. Cunningham in our own pages (vol. iv., p. 287), Grassi has arrived at the conclusion that the various forms making up the species of a Termes are produced at will by the community from similar individuals of an "undifferentiated" nature. His statements, in fact, amount to this, that the continuation of the species being confided by the community to a single pair, the produce of this couple is made into the various castes required by the community by means of processes of special feeding. Should the community require a new royal pair, they apply to a certain number of individuals a course of feeding by which the reproductive organs are brought into full development and functional activity, while the external parts of the body remain permanently in the pre-adult state. To such individuals the name "neoteinic,"[1] or "permanently adolescent," has been applied. Their number is afterwards reduced by the community to a single pair.

Dr. Sharp's exhibit included some 10 or 12 species of *Termites* that had been collected at Singapore by Mr. G. D. Haviland, and each species was represented by many of its various forms and most of the stages of individual development. In the nest of one species Mr. Haviland had found about 10 neoteinic pairs, leading to the belief that in this species also an economy prevails similar to that in *Termes lucifugus*, as described by Grassi. This Singapore collection, which contains a large number of specimens, all in a perfect state of preservation, has been presented by Mr. Haviland to the Museum of Cambridge University.

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### Botany; British and Foreign.

The May issue of the *Journal of Botany* contains descriptions of some of the new plants recently collected by Dr. J. W. Gregory in

[1] For explanation of term "neoteinic," see Kollmann, *Verh. Ges. Basel*, vii., 1883, p. 391; also Camerano, *Bull. Soc. Ent. Ital.*, 1885, p. 89, and *Atti Acc. Torino*, xix., p. 84

East Tropical Africa. Mr. Spencer Moore describes a number of Acanthaceæ, including a new genus, and Mr. E. G. Baker a new tree *Senecio*. There is considerable difference in size between our common groundsel (*Senecio vulgaris*) and the new giant which Dr. Gregory discovered growing on the rocky sides of valleys at an elevation of 13,000 to 14,000 feet on the south-west side of Mount Kenia. The woolly leaves of the latter are over a foot in length, and the stem grows to a height of 25 to 30 feet, attaining a diameter of a foot or more. This interesting plant is closely allied to one found by Mr. H. H. Johnston on Mount Kilima-njaro, and described by Professor Oliver a few years ago. Another tree *Senecio* occurs on the Abyssinian Mountains, and one in the Cameroons.

British botanists are not neglected, for in the same number several new native brambles are described. First, one by the Rev. W. H. Purchas, who admits that "It is certainly very undesirable to add to the already lengthened list of British brambles, unless very good cause can be shown for doing so; but" his plant "is so readily distinguishable from other forms, and is so plentiful and characteristic" in its locality "that it would be inconsistent with the treatment accorded to the rest of the genus to leave it without recognition as a well-marked variety." The plant in question was referred by Professor Babington and Dr. Focke, to a known species, *Rubus rosaceus*, but the Rev. W. R. Linton, who has enjoyed the best opportunities of studying it, from living in the same neighbourhood, "has made it increasingly evident" that "its strongest affinities are with the Caesian group." "Accordingly, the Rev. W. Moyle Rogers, who last year saw it growing," "considers that it should be placed under *Rubus dumetorum* as a named variety." Finally, however, the two other reverend gentlemen put their heads together and make a new *species*, *Rubus rubicundus*.

In order to let us down gently and relieve the monotony, the editor thoughtfully inserts the note on the new *Senecio* between Mr. Purchas's description and a paper entitled "Three New Bramble Forms," by the Rev. Augustin Ley, in which a new species from Herefordshire and two new varieties are described.

The genus *Rubus* is a fruitful one for investigation, the species of the British Isles having already supplied matter for no less than five papers in the journal for the present year. It is, however, interesting to note the apologetic tone in which new species are generally introduced. Thus, the Rev. W. Moyle Rogers, before proceeding to perpetrate three in the February number, remarks: "We must, I think, be anxious, all of us, to keep down and, where it may be possible, reduce the number of our *Rubi* 'species'." One cannot help thinking that these worthy clergymen have either not realised the fact of individual variation, or are so impressed with the origin of species by evolution, that in an excess of zeal they name them before they have actually arisen.

### Death Valley.

Under the title "Botany of the Death Valley Expedition," the U.S. Department of Agriculture have recently issued a bulky report, prepared by Mr. F. V. Coville, botanist to the expedition, and now head of the division of Botany. Death Valley, bounded on the east by the Funeral Mountains and westward by the Panamints, lies on the Nevada side of California, and forms part of the vast more or less desert region broken by short mountain ranges, which extends between the Rocky Mountains and the Sierra Nevada. In and about this cheerful region, Mr. Coville and his assistants spent more than six months of 1891, collecting plants and making observations on their habitat and environment. An idea of the nature of the country may be gathered from the following description:—"January 19 we broke camp, and set out for Death Valley by the old borax road. The excessive dryness of the region was evidenced by the fact that the pencil marks on a roadside grave-board, which had been twelve years exposed to atmospheric effects, still appeared clear and fresh, the surface of the wood retaining its natural appearance. We passed the night in Long Valley, and in the morning continued down the cañon, emerging into Death Valley near the south end of its alkali-flat. On either side were high mountains and between them the narrow valley, not more than ten miles wide. In the bottom of the valley was the snow-white stretch of salt and alkali, and to the northward, perhaps fifty miles away, mountains, valleys, and salt-flat vanished in haze. Creosote bush had been characteristic of all our route until we neared the salt-flat; but here, under the influence of clay and alkali, it gave way to greasewood (*Atriplex polycarpa*), that in turn to salt grass (*Distichlis spicata*), and the last to a shrub related to the pickle-weed." Beyond this there was no vegetation whatever.

The report, which occupies nearly 300 pages, is an example of what such reports should be, and an illustration of what can be done by a collector who is at the same time a proficient botanist. Besides an exhaustive catalogue of species, including descriptions of 42 novelties, and a tabulated list of specimens arranged in the order of collecting numbers, with date of collection, locality, and altitude, the author gives a valuable account of the distribution of plants in South-eastern California, and of the relationships of the mountain flora of the Sierra Nevada, and of that of Death Valley, and also discusses at some length the characteristics and adaptations of the desert flora. In a humid climate dew is an important source of moisture, but the weather-observer recorded no dew in Death Valley, and the several months' observations of desert conditions and phenomena have led to the conclusion that a very important proportion, perhaps in some cases all, of the summer water-supply of certain desert-shrubs is conserved in the soil as capillary moisture derived from local rainfall. The tree Yucca (*Y. arborescens*) is the nearest approach to the real tree that the desert affords, often attain-

ing 18 feet in height, but this is confined to the high altitudes. It is in the shrubby vegetation that the arid character is most reflected. The largest of the shrubs, the creosote-bush (*Larrea tridentata*) commonly grows to from three to five feet, while the height of most desert species ranges from this down to a foot. The struggle for continued existence is not with each other, as in a humid climate, since from scarcity of moisture each individual is separated by several yards from its neighbours, but against physical forces alone. A rounded form is the result of this spacing out, as, surrounded on all sides by light, the plants develop equally in every direction. No creeping or cone-shaped shrub is known in the desert.

An important principle in plant-life is the absorption of moisture from the soil by the roots, its conduction along the stem, and its transpiration from the leaf-surface; hence the study of desert plants reveals various adaptations for striking a living balance between absorption and loss of moisture. One device is great root development; thus the roots of the mesquite (*Prosopis juliflora*), a tree characteristic of desert areas with a moist subsoil, grow to enormous lengths; one was seen which reached more than 16 yards. As, however, during the season of drought the largest amount of water that can be absorbed is comparatively small, the greatest modifications are found in the stem and foliage. The size, form, and thickness of the leaves are most concerned. Thus, of forty-one shrubs examined, only four had leaves whose single-surface area exceeded a square centimetre. In some cases the leaves fall soon after the cessation of the spring rains, but in most they remain for the greater part of the summer, and to reduce loss of water to a minimum, have their surfaces protected by a resinous excretion or a covering of dry hairs. The creosote bush, for instance, owes its name to the resinous covering, in appearance like shellac, of its leaves and small twigs.

The twenty-one excellent plates of new species will serve to illustrate some of these points, and the large map at the end of the volume on which the route is indicated is also a valuable addition.

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### THE HATCHING OF THE OCTOPUS.

THAT an *Octopus* should be given to sit upon its eggs for the purpose of hatching them, like any barn-door hen, savours at first of the ludicrous, even though the instance of the female Argonaut which carries, if it does not incubate its eggs in its "boat," be borne in mind. More curious still is it that the habit was first observed and recorded by that astute old-time philosopher Aristotle, but subsequently forgotten till the discovery the other day in Lower California, by M. Diguet, of a new species of *Octopus*, which sets to work in a very systematic fashion, brought the circumstance once more to light. Aristotle remarked that the *Octopus* sits as soon as all its eggs are

laid, and in the same spot in which they are deposited—the crack of a rock or the interior of an empty shell—and he further notes that they do not feed while sitting, so that they become quite thin.

The marked peculiarity concerning the new species, which is described by MM. Perrier and Rochebrune (*Comptes Rendus*, vol. cxviii., p. 770) under the name of *Octopus digueti*, appears to be that it habitually spawns in empty bivalve shells (*Cytherea*, *Pecten*, etc.), lining the interior of the two valves with its eggs, and itself occupying the intervening space. Whether it merely remains in this situation during incubation, or whether, hermit-crab-wise, it makes its abode in empty shells a matter of permanent policy, does not transpire; but MM. Perrier and Rochebrune, judging from their concluding remarks, evidently incline to the latter idea. In fact, this habit is merely a specialisation of the ordinary habit possessed by these shell-less Cephalopoda of protecting their soft bodies by inserting them in foreign shells, rock crevices, old tins, or whatever first presents itself.

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### Nerves of Molluscs.

A long and apparently most careful paper on the histology and organology of the nervous centres of Gastropoda as exemplified in the genera *Helix*, *Arion*, *Zonites*, and *Limax*, from the pen of M. B. de Nabias, has just appeared in the *Actes de la Société Linnéenne de Bordeaux* (vol. xlvii., pp. 11-202, 5 pls.).

As the author justly remarks, the microscopic structure of the nervous system of the Gastropoda—indeed he might have said of Mollusca generally—is almost totally neglected, attention being devoted solely to the external topography. Mr. Nabias' researches show that there exist two sorts of nervous cells in the nervous centres. First, ganglionic cells properly so called, of variable size, that occur in the subœsophagian centres, in the visceral ganglia, and in the posterior portion of the brain, where they are disposed radially round the central fibrillary mass. The larger cells are near the periphery, the medium-sized and smaller ones in closer proximity to the central mass. Secondly, small spherical cells of uniform size, only met with in the anterior region of the brain (Protocerebron), in the terminal ganglia of the tentacles (both upper and lower) and the ganglion of the external labial nerve, which must be considered as the gustatory nerve.

The number of cerebral nerves, amounting to nine pairs, are constant for the five genera. M. Nabias distinguishes three regions in the cerebral ganglion—protocerebron, mesocerebron and post-cerebron—for the last of which the term metacerebron would have been preferable.

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### Nullipores.

It is already well-known that the small calcareous marine Algæ, commonly termed "Nullipores," sometimes form great deposits of

massive limestone among rocks of the Tertiary and perhaps the latest Cretaceous periods. Hitherto, however, only insignificant remains of these organisms seem to have been recognised in strata of earlier date. Geologists will, therefore, peruse with much interest the paper by Dr. Alexander Brown on *Solenopora*, published in the April and May numbers of the *Geological Magazine*. *Solenopora* is a problematical calcareous organism of varying size, ranging from the dimensions of a pea to those of an orange, and of irregular shape; and it occurs abundantly in the Ordovician (Lower Silurian) rocks, where it sometimes forms great beds of limestone. Dr. Brown attempts to prove that its structure is cellular, not tubular as previously supposed, and that there are occasionally appearances which can only be compared with the "tetrasporangia" and "conceptacles" of recent corallines. It is thus extremely likely that the problematic fossil in question will prove to be a nullipore, and in that case the range of these minute organisms as rock-builders is extended backwards to early Palæozoic times.

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### An International Catalogue of Scientific Publications.

In the *Bulletin de l'Académie Royale de Belgique* for April 7, M. Mourlon has a paper on the formation of an International bureau for Bibliography. He refers to the scheme read before the Academy on December 4 last by M. F. Van der Haeghen, for the compilation of a General Catalogue of the contents of public libraries, and proceeds to quote a letter received from the Royal Society of London, dated March 22, 1894, and signed by the secretaries, Professor M. Foster, Lord Rayleigh, and Sir J. Lister.

This letter, which we presume has been sent to other Societies besides the Royal Academy of Belgium, announces the proposed preparation of a Catalogue of all "scientific publications, whether appearing in periodicals or independently," and goes on to say that, as such a "Catalogue is far beyond the power and means of any single Society," the "Royal Society have appointed a Committee to inquire into and report upon *the feasibility of such a catalogue being compiled through international co-operation*." "The Catalogue should commence with papers published on or after January 1, 1900."

This excellent suggestion has been made many times before, and we are glad to hear that the Royal Society of London is taking some practical steps in the matter. But we are curious to learn the names of those forming the committee, that there may be some guarantee of special knowledge in the decisions arrived at. That the Royal Society failed to attain reasonable completeness in their "Catalogue of Scientific Papers" is generally felt, and in their letter referred to this is definitely acknowledged. But the reasons therein given for this failure are lamentably feeble, for they say that this incompleteness is "owing to the omission of the titles of papers published in

periodicals of little importance, or not easy of access." Now, in the first place, it is not for compilers of catalogues to judge whether a periodical is, or is not, of "little importance." The importance of an article, or of a note for that matter, is decided by its importance to the individual who wishes to consult it; it cannot be valued by the clerk who transcribes. In the second place it is the experience of most of those who have to consult periodicals, that they can find in one or other of the great libraries in London practically everything they wish to consult. Judging by our own experience of the "Catalogue of Scientific Papers," published by the Royal Society, the rich collections of scientific serials at Bloomsbury, and the still richer collections stored in the Natural History Museum at South Kensington, could not have been consulted very carefully by the compilers.

Turning to foreign publications of the same nature, we find that the more convenient "Bibliotheca Historico-Naturalis" of Engelmann (1846), the "Bibliotheca Zoologica" of Carus and Engelmann (1860), with the continuation now publishing under the editorship of Taschenberg, reaches a far higher level of completeness in the special subject with which these volumes are concerned. The reason for this is seen in the fact that the German compilers have a special knowledge of the subject upon which they work, and take infinitely more pains to render their work perfect. Only a year or so ago Dr. Taschenberg himself paid a special visit to this country to consult the rarer English publications in order to minimise, as far as possible, the number of omissions.

These catalogues, if they are to be compiled at all, should not suffer from the neglect of periodicals "of little importance or not easy of access," and we sincerely hope that the Royal Society of London, if it attempts the publication of a Catalogue such as it proposes, will use the experience gained by their acknowledged failure, will model their work on Engelmann, Carus, and Taschenberg, both in completeness and size, and make their part of the proposed Catalogue worthy of the subject, and of the money which must be spent upon it.

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### Records of Scientific Literature.

We have often referred in these pages to those books known as Records of Scientific Literature, which have for object the assistance of the systematic scientist, by cataloguing and arranging the vast flood of papers and books published during the year on scientific subjects. It is our intention, in an early number of Natural Science, to bring together a list of the more important of these valuable time-savers, to show, in the first place, what has been and is being done in this direction, and, in the second place, to bring before the notice of would-be compilers, the importance of some international action as proposed by the Royal Society in

the letter referred to above, in order to save the duplication of work, and the extravagant expenditure of energy and money, which result from the numerous independent publications all tending to the same end. The most striking illustration of the waste in this direction is perhaps seen in the fact that no less than three recognised publications are issued year by year dealing with zoological literature, viz., the *Zoological Record*; the *Zoologischer Jahresbericht*; and the *Zoologischer Anzeiger*. In Geology the case is not at present so bad, for D'Agincourt's *Annuaire* is the only publication embracing, or rather attempting to embrace, the geological literature of the whole world. There are, however, numerous other geological records of local interest, as Blake's *Annals of British Geology*, Nikitin's *Russkaya Gheologicheskaya Biblioteka*, and the *Bibliografia Geologica Italiana* of the Italian Survey. As it has been proved more than once that the scientific public will not support these works, despite their enormous value, it behoves all those interested in the cataloguing of scientific literature, to consider any scheme whereby the necessary catalogue can be produced without the doleful interruptions due to non-support, incompleteness, unpunctuality, or neglect, which have characterised these publications in the past.

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### BOULDERS AS SOURCES OF ERROR.

IN *Nature* for May 3, Professor McKenny Hughes has an interesting letter on the above subject. He points out that a quantity of rubbish of all descriptions is taken by barges down the lower Thames and spread on the adjoining lands. Thence it is carried on "with road scrapings, fragments of every kind of road metal; with soil turned out in digging foundations, specimens of all the materials used for building; with the contents of middens, and every variety of object of domestic use and ornament." He himself has seen pieces of Napoleonite on the surface in North Kent! Then, with regard to the soils washed out of a cliff of boulder clay, although in the majority of cases there is no doubt as to their origin, Professor Hughes points out that there is another serious source of error, of which he gives a good example.

"A Norwegian vessel, carrying timber from Christiansund to Boston, in Lincolnshire, ran aground and became a total wreck off Old Hunstanton last winter. I saw her in January. The vessel looked sound enough to a landsman's eye; but she was dismasted and gutted, and the salvage was on the sand dunes close by. About her a pool of varying breadth had been formed by the swirl of the water round the hull. The currents had been deflected by various circumstances here and there, as especially where a quantity of ballast had been thrown out. This consisted of large boulders of various kinds of gneiss and porphyry, and the weighty pile looked as if it were little affected by the currents of the incoming and receding tides.

"In April, I visited the spot again, excepting to find that the boulders had been driven along the shore by the fierce storms which had raged along that coast since my previous visit, and intending to make note of their dispersal and the distance to which they had travelled. I found, however, that the keel and a portion of the lower part of the wreck remained, and that the surrounding pool was greatly deepened and extended. Through the deep clear water I saw the heap of ballast, which had been undermined and was settling down into the depths, being already far below the level of the surrounding sand. When the last of the timber shall have yielded to the axe and the waves, the sand will soon level up the hole caused by the scour round the obstructing mass, and this heap of Scandinavian boulders will lie buried in the sand till some exceptional storm shall shift the banks, and expose them again, and perhaps transport them along the shore.

"Had this vessel been thrown on a hard rocky shore instead, the ballast would have started at once with the other boulders on the shore, and been scattered, according to size and form, along the coast. As it was, however, these have got buried deep in sand, and preserved till, perhaps, the habit of using such boulders for ballast shall have been given up, and then, washed out by the accidents of weather, of coast destruction, and of shifting sand, they will appear among the fallen fragments of a boulder-clay cliff, and be appealed to in proof of its origin.

"How many ships with Scandinavian ballast have been wrecked along our eastern coast ever since the time of the Vikings? How many hundred tons of such boulders are still travelling round our shores?"

At a meeting of the Geologists' Association of London, on May 4, Mr. W. W. Watts read a paper on behalf of Mr. A. C. G. Cameron, "On some boulders of chalk in the Boulder-clay of Huntingdonshire." These masses were of large size, and were evidently torn from the original mass, and were in no way "reconstructed" chalk. It was pointed out that one of these masses was considerably more than half-a-mile long, about a quarter of a mile wide, and of unascertained thickness. Upon it, the greater part of the village of Catworth was built, the inhabitants of which derived an abundant supply of water from wells sunk into the mass, this commodity being difficult to obtain by those living on the surrounding surface of boulder-clay. Such a block of chalk as this raises similar interesting questions to the travelled blocks of Professor Hughes. But in this case we cannot invoke the Vikings. As was pointed out at the meeting of the Association, it is difficult to imagine the ice-force necessary to tear away from the parent rock so prodigious a mass of chalk, leaving out of the question the quantity of ice necessary to lift and transport such a mass bodily over the country.

## THE SUTHERLAND GOLD-FIELDS.

IT seems likely that the Sutherland gold-diggings will be re-opened in a few months after having been abandoned for twenty-five years.

The facts known about the mode of occurrence and source of this gold appear to be few and elementary. All the gold obtained was alluvial, and the diggings were along three streams—the Kildonan, Suisgill, and Kinbrace burns. These are tributaries, on the eastern side, of the Helmsdale River, which drains a considerable area in N.E. Sutherland. Gold was also found in small rills on the western side, and, as might be expected, in the main river.

The diggings were in terraces of coarse, sandy gravel which skirt the streams, and in the present detritus of their beds, the rock-pockets being the richest. Whether gold was ever found in the parent rock seems uncertain. It may exist finely disseminated in it, and does not appear to be derived from vein-quartz. The country drained by the three burns consists of quartz- and mica-schists traversed by granites, and belonging to that Eastern Highland series over the age and origin of which so much mystery still hangs.

It is not likely that speculation concerning the source of the gold will be very fruitful until many more localities have been searched, and until much more is known of the distribution of the rock-groups in East Sutherland. This we may look for before very long, as the Geological Survey is now at work there. Then, perhaps, some connection between the occurrence of the gold and the nature of the rocks may be found, and light may be thrown on a subject which, though not very important (at least at present) from an economic point of view, has always a certain scientific interest.

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WE are pleased to note that the Government of Western Australia has decided to reserve a large tract of public land in the colony as a "National Park" for the preservation of the native fauna and flora. At the suggestion of Mr. Bernard H. Woodward, curator of the Government Museum, an area of 160,000 acres has been selected on the Darling Range, between the Albany and Bunbury roads, midway between Bannister and Pinjarrah, and within a reasonable distance of Perth. It is one of the most picturesque parts of the range, having many serrated mountain peaks, and being exceedingly wild and rugged. It is said to be exactly the site required for the preservation of the kangaroo, with other marsupials, and the emu, of which there are still a certain number left upon it.

I.

# Cell-Division.

## PART II.

IN the number of NATURAL SCIENCE for January of this year an attempt was made to give a more or less up-to-date account of the karyokinetic method of cell-division. The present article proposes to discuss the phenomenon briefly in its bearing upon reproduction and the segmentation of the ovum, and also to pay some attention to points of theoretical interest in the same connection. Before doing so, however, it will be advisable to consider that other form of nuclear division, viz., Amitosis, or direct division, to which reference was made at the conclusion of the former article. This course is almost necessitated by the fact that recent observations tend to show that amitosis sometimes occurs where theoretical considerations would naturally lead one to expect karyokinesis. If the accuracy of these observations be allowed, it would seem that much that has been written on the significance of karyokinetic division in the transmission of hereditary substance must be reconsidered, if not laid aside as no longer compatible with attested facts.

### *Amitosis, and its Relation to Mitosis or Karyokinesis.*

Amitosis has been stated by many observers to occur normally both in unicellular organisms and in the tissues of higher animals and plants.

Firstly, as regards its occurrence in the Protozoa. The student of nuclear division in these animals must draw a sharp line of demarcation between those forms which possess both a macro- and micro-nucleus, *e.g.*, *Paramœcium*, and those which, like the common amoeba, possess only one. In the former instances, the macro-nucleus invariably divides amitotically. Can the same be said of the single nucleus of the latter? Flemming, Ziegler (18), and those who seek to show that amitotic division is invariably a sign of the degeneration of the nucleus that exhibits it, maintain that in those forms which have only one nucleus the division is always accompanied by karyokinesis. Hence, if it can be proved undoubtedly that amitotic division may take place in such forms as *Amoeba*, it follows that the view of those authors must be disregarded, at any rate in so far as

it applies to the Protozoa. It is somewhat surprising that little careful investigation of this latter point has as yet been made.

Secondly, as regards the occurrence of amitosis in the Metazoa. Although a few authorities still doubt its existence, it seems clear that, if we are not to disregard a large number of observations, amitotic division of nuclei does actually take place. This fact was first insisted on by Flemming, and the subject has been carefully worked out by Ziegler and others. These observers have shown, in the first place, that nuclei which divide directly are always of relatively enormous size, a condition probably the result of unusually intense secreting or assimilating processes going on within them. For instance, the ovarian cells of many insects act as conveyers of nutriment to the growing ovum. These cells possess large nuclei, which have been observed to break up directly into two or more pieces, although there is no corresponding division of the body of the cell as a whole. Again, the brood-pouches of certain molluscs are lined by cells which pour into them a nutritive fluid. These cells have large, irregularly-shaped nuclei, which undergo rapid amitotic division preparatory to disintegration. Further, it has been shown that the cells lining the mid-gut of insects have the function of gland-cells. They are continually being given off from the inner surface of the gut, and new cells are formed from underneath to supply the place of the old ones. These young cells are formed, in the first instance, by karyokinetic division, but as soon as they become functionally active, their nuclei swell up and divide directly into several pieces. Soon afterwards the cell dies and is thrown off. To take one more instance, this time from the Mammalia, it has been noticed that amitotic division characterises the nuclei of the epithelial cells in the uterine wall preparatory to parturition. Lastly, amitosis is of frequent occurrence in the cells of pathological growths of all kinds. In all these examples it must be noticed that, although nuclear division takes place, there is no corresponding division of the cell-body, and, further, that amitosis is a characteristic of nuclei that have taken on a special function, leading to the speedy death and disintegration of the cell.

It is, however, by no means true that amitosis is never accompanied by cell-division, or that it is always followed by nuclear degeneration and a stopping of cell multiplication. In the spermatogenesis of many animals, it appears that the sperm-mother-cells divide amitotically up to a certain point, after which karyokinesis marks their further division into spermatoblasts. In the development of the spermatozoa of *Branchipus*, Moore (14) has shown that some of the primitive genital cells break down to form a fluid, in which lie the spermatozoa produced by the remainder. The former are the product of repeated amitotic division, the latter of karyokinetic. But the more striking instances of fragmentation of the nucleus are met with in the fertilised ova of many animals. Henking, among others, has made careful investigations on insect

ova (10), and in a large number of cases has shown that the first segmentation nucleus may entirely disappear, and all trace of chromatic or achromatic substance vanish. The chromosomes appear to break up into minute granules, and to become scattered throughout the protoplasm of the ovum, where, by fusion, they apparently, later on, form the "free" or "yolk" nuclei. It must, however, be noticed that no trace of division into blastomeres is to be found till normal karyokinetic division sets in. The chromatin of the first nuclear spindle appears to be the result of a fusion of some of these nuclear granules. There appears, moreover, to be, in insects at any rate, every condition between a regular karyokinetic division of the first segmentation nucleus and an irregular fragmentation of the same. The limits of this article forbid further examination of the evidence in favour of the fragmentation of the nucleus, but it should be mentioned that in the spore-formation of many Protozoa a similar breaking-up of the nucleus takes place, without any trace of karyokinesis. Hickson has, in a recent paper (11), reviewed the literature on the subject, besides giving details of his own observations, and the conclusions he draws appear to be the most probable at the present state of our knowledge. They are:—

1. Fragmentation of the nucleus is a normal method of nuclear division, and is not always a sign of pathological change, or, indeed, of anything abnormal.

2. In many of the instances in which the nucleus is supposed to disappear, there is, as a matter of fact, minute fragmentation of its component parts.

3. Fragmentation of the nucleus is never followed by any kind of corresponding division in the body of the ovum.

It is certain that no hard and fast line can be drawn between mitosis and amitosis, since many recorded observations prove how the one passes almost imperceptibly into the other. There remains, however, the question as to which of the two is the more primitive. To give an answer in the least degree probable is a matter of considerable difficulty, if not of impossibility. In the first place, it is almost necessary to postulate the past existence of non-nucleate organisms, even if it cannot be allowed that there are any such living at the present day. It is equally essential to assume that they must have reproduced themselves in some way or other, either by dividing into equal halves, or by breaking up into irregular pieces. Hence, before the nucleus was developed, there were already forces residing in the cell-substance, tending either to pull it into equal halves or into many pieces. After the appearance of the nucleus in those individuals which had normally multiplied in the former manner, regular karyokinesis would take place, while in the latter case fragmentation of the nucleus could have been the only possible cause. The latter method appears to have become rarer and rarer in the Metazoa, probably because the nucleus took on a more definite

plan of structure, necessitating an exact division of each of its component parts. It is difficult to imagine such a complicated process as karyokinesis arising suddenly in a small nucleated mass of "Urschleim," or primordial protoplasm. It would seem more natural to imagine the nucleus dividing irregularly at first, which division gradually became more and more precise as the importance of the nucleus as an element in the cell increased. It cannot be considered, however, that amitosis, when it occurs in the Metazoa, is a reversion to a primitive condition. There can be little doubt that it is an acquired process, dependent on some special change in the nucleus or cytoplasm.

*The Relations of Nuclear Division to Reproduction and Segmentation.*

It is well known that the essential process of fertilisation is the conjugation or "fusion" of the head of the spermatozoon, with the nucleus of the ovum. In order to understand the nature of the phenomenon, it is necessary to study the part played by each of the two elements concerned. The head of the spermatozoon, or sperm-nucleus, is practically a mass of chromatin, with nothing resembling the achromatic network of a resting nucleus. The body, or middle piece, is the centrosome, the nature of which was fully discussed in the first part of this article. The tail consists merely of vibratile protoplasm, and either drops off while the spermatozoon is still in the periphery of the ovum, or may persist for a while in the substance of the egg, eventually becoming detached from the head and finally absorbed. The head itself, after penetrating into the egg, may either (*a*) be transformed immediately into a resting nucleus with membrane and achromatic network, a condition it maintains throughout, or (*b*) having first passed into a resting condition, later on its chromatic elements may become collected to form one or more chromosomes, but always a definite number for every species, while the achromatic elements and the membrane simultaneously disappear.

In *Ascaris megalocephala*, the classical object for research on nuclear structures, the sperm-nucleus always possesses a certain number of large chromosomes in the form of threads or rods. The whole process of fertilisation has been most minutely studied by Van Beneden, Boveri, Carnoy, and others. The egg-nucleus is precisely similar in appearance, and in the number of chromosomes it contains, to the sperm-nucleus. To reach this condition, it has had to undergo important changes and losses, caused by the so-called "reducing division," or extrusion of the polar bodies. The significance of these structures has been interpreted in many different ways, some of which will be briefly touched upon later. It is enough at this point to call attention to the fact that, by a reduction in the amount of chromatin it originally possessed, the egg-nucleus has come to exactly resemble in all outward features the metamorphosed head of the spermatozoon. Passing on now to the actual process of fertilisation, Van Beneden

has observed that, in one species of *Ascaris*, both the egg- and sperm-nuclei (male and female pronuclei), contain a single varicose chromatin thread. As they approach one another, the thread in each divides transversely into two halves, both of which become looped and again divide, this time by longitudinal splitting, into four apparently identical pieces. The two nuclei then come into close contact, and the eight threads, from male and from female, arrange themselves in the equatorial plane of a spindle, which has by this time been formed by the activity of the centrosome brought into the ovum by the spermatozoon. The threads gradually travel towards the poles of the spindle, and a separation is effected between them in such a way that each of the daughter-nuclei is formed out of four chromosomes, two derived from the female and two from the male. Constrictions now appear, dividing the ovum into two blastomeres, the nuclei of which have by this time passed into a resting condition. It will be seen from the foregoing account that there is no true fusion of the chromosomes of the two pronuclei, but only a mingling together of their substance. Indeed, the notion that in the fertilisation of any ovum the two nuclei actually fuse to form one, or that any part of them do so, is gradually being given up.

There still remain to be considered those cases in which the two nuclei copulate while in a typically resting state. The process of fertilisation in the leech *Nephelis*, which the present writer has had the opportunity of studying, affords a good case in point. Both pronuclei are in a state of perfect rest during the whole time; all that appears to happen is the breaking down of the two membranes of the adjacent nuclei at the point of contact, allowing a mingling of the chromatic and achromatic elements, which results in the formation of a single large nucleus. This also remains some time in a state of rest before it proceeds to karyokinetic division.

It would seem, therefore, necessary to distinguish those cases in which the two pronuclei fuse, so as to give rise immediately to a nuclear figure, from those in which copulation takes place between two resting pronuclei to form a single nucleus in the same condition. What the significance of these two modifications may be is not clearly understood.

*Nuclear Division in Relation to Points of Theoretical Importance.*

Since the nuclear matter is so obviously concerned in the process of fertilisation, it is legitimate to hold that the nucleus is the seat of the hereditary substance which the parent transmits to its offspring. Strasburger and O. Hertwig were among the first to advocate this view, and it has now come to be generally accepted that only the chromatin of the nucleus is the bearer of the hereditary tendencies. This view is supported by the fact that paternal characters can be inherited just as well as maternal, although the amount of protoplasm in the two germ-cells is greatly disproportionate.

Further, the persistent part of the spermatozoon is practically nothing more than a mass of chromatin and a centrosome. The latter is, without doubt, merely an organ for division, although one author has recently tried to show that the centrosome is the bearer of parental qualities to the entire exclusion of the chromatin substance. If it be granted, therefore, that the chromatin is the bearer of the hereditary tendencies, it is of the greatest importance to trace out the changes which the chromatin of the egg- and sperm-nuclei undergo preparatory to copulation.

Mention has already been made of the "reducing division" of the nuclear matter of the egg-cell by means of the polar bodies. These structures have been noticed for some considerable time, and there has been much speculation as to their real nature. The following are some of the more important suggestions which have been made in order to explain their presence:—

1. The earlier authors considered them to be excretory products which the ovum had to get rid of.

2. Kölliker regarded them as a means of rendering the egg-nucleus the same size as the sperm-nucleus.

3. Flemming thought they represented a parthenogenetic mode of development possessed by the ova of earlier ancestors.

4. Hertwig and Boveri look upon the formation of the polar bodies as nothing more than unequal cell-division, strictly comparable to what happens in the formation of the spermatozoon. Boveri has constructed two diagrams, reproduced here, to illustrate this point (3), and has invented a new nomenclature for the germ-cells in the various stages of their development. From an inspection of these diagrams it will be seen that the first polar body corresponds to a sperm-mother-cell, while the second corresponds to a spermatozoon. While the diagrams illustrate strictly the number of divisions which the ovocyte I. and spermatocyte I. undergo, viz., two, there are more series of cell-divisions than represented in the upper part of the diagram for the zone of germination. These diagrams will be subsequently referred to in considering the fate of the chromosomes in the reducing division.

5. Minot and Balfour, as is well-known, regarded the polar bodies as representing outcast male elements, and postulated a somewhat similar process taking place in the formation of the spermatozoon, by which corresponding female elements were got rid of. Thus, these two authors considered the primary germ-cells to be essentially hermaphrodite.

6. Weismann sees quite a different significance in the polar bodies. According to his earlier view, nuclear matter presents two modifications, viz., germ-plasm and histogenic nucleoplasm. The former is only found in the germ-cell, and is the hereditary substance passed on from parent to offspring. The latter is the element which determines the nature and directs the growth of the cell which contains it.

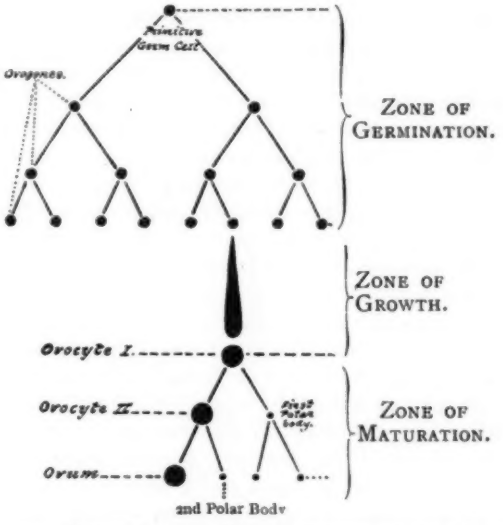
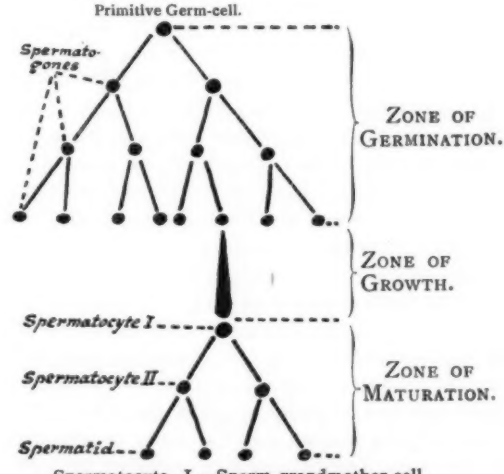



Diagram Showing the Development of the Egg-Cells in Ascaris megalocephala (*after Boveri*).




Spermatocyte I. = Sperm-grandmother-cell.
Spermatocyte II. = Sperm-mother-cell.
Spermatid = Spermatozoon.

Diagram Showing the Development of the Sperm-Cells in Ascaris megalocephala (*after Boveri*).

Thus, the nucleus of a nerve-cell would contain a different kind of histogenic plasm from that of a gland- or muscle-cell. As soon as the ovum has arrived at maturity, its own histogenic plasm has become superfluous, and is therefore got rid of in the shape of polar bodies. When, however, it became known that, whereas in sexually reproducing ova two polar bodies were extruded, in those which developed parthenogenetically there was never more than one,[1] Weismann was forced to attach another meaning to the second polar body. This he did by suggesting that it was a means of keeping the number of ancestral units in germ-plasm from increasing; were there not some such method the germ-plasm would be doubled at every fertilisation, and soon grow too large to be contained in the nucleus. It is possible that this idea was based on certain erroneous observations as to the exact method of nuclear division in the formation of the second polar body. The point is far too complex to be entered upon here, but it has been adequately discussed, and criticised by Boveri (3) and others.

After the publication of Hertwig's (10) admirable researches on the spermatogenesis of *Ascaris*, Weismann considerably modified his views. It was shown, or at any rate Weismann has gathered from Hertwig's work, that the youngest sperm-mother-cells possess nuclei which are characterised in the active stage by the presence of four chromosomes. These cells (spermatogones, to use Boveri's nomenclature) increase by ordinary karyokinetic division, *i.e.*, longitudinal splitting of their chromosomes up to a certain point. When this is reached, the cells cease to multiply, but grow considerably in size, and their nuclei pass into the resting condition. On again becoming active, the nuclei are seen to possess not four rods as heretofore but eight. At this point the reducing division sets in. Each cell (spermatocyte I.) divides into two (spermatocyte II.), each of which again divides, forming two daughter-cells, which are the true spermatozoa (Spermatids) (*see* diagram). It must be noticed, however, that in both these latter divisions there is no longitudinal splitting of the chromosomes, but half the number of rods pass into the daughter-nuclei. Since there are two reducing divisions, it will be seen that each spermatozoon eventually comes to possess two rods, *i.e.*, half the number contained by the original spermatogone. The process in the formation of the ovum is exactly similar to the above, the sole difference being that, whereas in the male cells the reducing division of the spermatocyte I. gives rise to four equal spermatozoa, that of the ovocyte I. gives rise to three polar bodies[2] and the ovum, of which only the last is functionally active. Therefore, the ovum before the extrusion of the polar bodies is the homologue of the sperm-grandmother-cell or spermatocyte I.

[1] Blochmann, however, has described two polar bodies in the parthenogenetic ova of *Apis* and *Liparis*, and Brauer has shown that the same is the case in the parthenogenetic eggs of *Branchipus* and *Artemia*.

[2] The first polar body divides into two, making three in all.

This reducing division has excited great attention among biologists, and scarcely a week passes without some new contribution to the already extensive literature on the subject. It is only possible here to give the briefest mention of the view that Weismann now holds. This author considers the nuclear chromatin rods, or "idants," to be composed of individual masses of ancestral plasms, or "ids," each of which could, if it alone dominated the ovum, control the whole course of development, and give rise to a complete individual of the species. The doubling of the idants before the reducing division is a means of increasing the number of possible combinations among the ids, and of thereby ensuring that as many spermatozoa as possible shall possess the hereditary tendencies balanced in different proportions. By this means, which equally well applies to the ovum, the organism resulting from the union of two individuals may differ markedly from its parents, or, in other words, may exhibit considerable variation from the specific type.

Before leaving the subject of the reducing division, it should be noticed that a similar process occurs in the Protozoa. Maupas has shown that the micro-nucleus of the Ciliata, which alone takes any part in conjugation, undergoes as many as three reducing divisions before it is ready for action. In some lowly-organised plants (Desmidiacea) reducing division takes place after two individuals have fused to form a zygote.

Lastly, Boveri has carefully traced the method of nuclear-division in the segmenting ovum of *Ascaris*, and finds that large masses of chromatin may be extruded bodily from the cells. Further, he has discovered that the ovum divides, at its first segmentation, into a somatic-cell and a germ-cell. The difference between them is marked by the way their nuclei divide. Whereas the former cell and its descendants divide in a more or less rough and ready manner (though always karyokinetically), and masses of chromatin are extruded bodily from the cell, the latter divides, with the exactest halving of its rods, into two, one of which halves repeats the division of its parent, while the other segments in a manner similar to the somatic cells. Thus, up to a certain point in ontogeny, there is in the embryo, at any given period, one cell which is a product of perfect karyokinetic division. Beyond this stage all the descendants of this cell divide similarly to it, and give rise to the germ-cells. Thus there is a perfect continuity of the nuclear matter from the two-celled stage in development up to the ripe sexual elements of the adult. Boveri's results are, therefore, a striking proof of Weismann's theory of the continuity of the germ-plasm, as far as outward form goes.

The above account deals with some of the main points in which cell-, and more particularly nuclear, division are of importance, as regards both the actual process of fertilisation and development. It is naturally impossible to give any clear idea of Weismann's elaborate theories based on nuclear structure and the changes it under-

goes; but it was felt that it would be equally undesirable to entirely pass over all theoretical speculations. Without some connecting idea, the facts themselves lose much of their interest, and biologists must of necessity pay close attention to such work as Weismann's, even if they have to find subsequently that some new discovery renders that work no longer tenable as affording an adequate explanation of the facts as they stand. Though to some minds Weismann's doctrines may extend into the regions of transcendental science, yet his works, and those of the Hertwigs, Boveri, and other eminent cytologists, have brought home to all an immense and varied field of possible research, the results of which may in the future, as they have done in the past, profoundly modify the position of Biological Science.

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## II.

# Can the Sexes in Ammonites be Distinguished?

ALL living Cephalopoda known to us have the sexes separate; no hermaphrodite species has been discovered. It is therefore natural to suppose that the extinct Ammonites were similarly unisexual, some specimens being male, others female. If this be admitted, it becomes of some importance to ascertain whether the difference of sex affected the hard as well as the soft parts of the animal, and, conversely, whether certain differences of form that distinguish individuals may not be of sexual rather than of varietal or specific nature. Clearly it would be wrong to give separate specific names to individuals whose only difference was that of sex.

The opinion that such secondary sexual characters are manifested in Ammonite shells has long been maintained by many eminent authorities, notably among French palæontologists. The first to suggest it seems to have been Ducrotay de Blainville, in his "Prodrome d'une monographie d'Ammonites," Paris, 1840. "Unknown," he said, "though the Ammonite animal be, yet analogy drawn from what we know of the Nautilus does not allow us to doubt that the sexes were separate in different individuals. The females, then, must have had the ventral side more swollen by the ovaries replete with eggs at a certain period. Hence the shell and its aperture must have betrayed these differences by a size and swelling in the former and a relative width in the latter, both greater in female individuals than in those of the male sex, since the semen of the males could never reach such a development as the fertilised ova of the females." De Blainville was followed by d'Orbigny and many other palæontologists. Pierre Reynès, in the Monograph cut short by his untimely death (1879), strongly upholds the distinction of the sexes, saying—"The difference in the dimensions of shells equally ornamented seems to be one of the most convincing proofs. Among individuals, some are slight and of compressed shape, while the whorls of others are broad; we think that the first are the males and the second the females. . . . It results from the comparison of a certain number of individuals of the same species that, without any

doubt, among Ammonites, the compressed forms are almost always accompanied by swollen forms, and that these two forms are constantly associated. The ornamentation and septa are identical; the individuals only differ in the involution and width of their whorls. Anyone making a general study of Ammonites can easily convince himself that the majority of species have two distinct forms, and can prove this whenever the material is sufficiently plentiful. To what cause can this difference of thickness be attributed if not to sex? Ornament is often more pronounced in one sex than in the other, although identical in general arrangement. The ribs and tubercles are then more marked and their number is less; in this case the furrows have a greater depth (*A. bifrons*, *Murchisonæ*, *Martiusii* [*sic*], *Truellei*, *Duncani*, etc.). In other species the ornament is in no way changed, the whorls preserve their ordinary proportions, and are not modified in any of their parts."

That differences, not of specific importance, do exist between individual shells, will not be denied by anyone who has studied large collections of Ammonoidea; and these differences may be due to sex, with at least as much probability as to any other cause. The smaller size of the male is certainly paralleled among recent Cephalopoda, *e.g.*, *Sepia*, *Sepiola*, *Loligo*, *Argonauta*. For the views enunciated by Reynès and the other palæontologists mentioned above, something might perhaps be said within small limits; but modern research has done much to disprove them. First, the supposed males and females are found to be not always contemporaneous when the strata are critically examined. Next, the thick and thin forms of a "species" are replaced in modern collections by a great number of forms in all degrees of compression, and these forms do not exhibit that strict agreement in details of ornamentation, etc., which we should expect to find after reading the accounts of these authors. Finally, it has yet to be proved that the thicker forms did actually possess body-chambers of larger capacity than their thinner relatives. It would be so, of course, if the length remained the same; but our investigations rather indicate that the length varies with the degree of compression, so as to maintain, among relatives, the same size of body-chamber in proportion to the whole shell. For instance, in *Stephanoceras* the body-chamber varies in length from about half a whorl in the thick forms (the supposed females) to very nearly two whorls in the thin forms (the supposed males). If the "female" had to enlarge her body-chamber for the accommodation of the eggs, it is obvious that her body-chamber ought to be larger in proportion to the whole shell than is the body-chamber of the "male," who was not called upon to provide this extra house-room.

Recent writers on the subject have therefore gone upon another tack. In their over-anxiety to obey the behest "cherchez la femme!" two well-known French authors have set themselves to prove that the two sexes in the Ammonites differ not only in compression, but in

ornamentation, in shape, in size, in septation, and in the processes at the shell-aperture.

First comes Munier-Chalmas, who, in the *Compte rendu de la Société géologique de France* (no. 14, p. 170, 1892), explains his views on the subject. He considers that the males among Ammonites are represented by certain "scaphitoid" forms, as he calls them, which are distinguished by the following characters:—1. The last whorl is more or less bent back (*réfracté*). 2. The edge of the shell aperture (*péristome*) is furnished with a double process—one auricle on each side —(*apophyse jugale*). 3. The size is relatively small. 4. The evolution of the septa is rapidly arrested.

As types of these *Scaphites*-like Ammonites, Munier-Chalmas indicates the following genera with which we are already acquainted:—*Œcotraustes*, Waagen; *Œcoptychius*, Neumayr; *Sutneria*, Zittel; while he himself adds, as new genera, *Cadomoceras*, of which the type-species is *Ammonites cadomensis*, d'Orb.; *Horioceras*, with type-species *A. baugieri*, d'Orb.; and *Creniceras* which has for type *A. renggeri*, d'Orb. The species belonging to these forms are considered by Munier-Chalmas to be the males of other species, which are females. Thus, *Œcotraustes genicularis*, Waagen, is assigned as male to *Oppelia subradiata* (Sow.); *Horioceras baugieri* (d'Orb.) is made to ally himself with *Distichoceras* (n.g.) *bipartitum* (Zieten); and so on. Why, if these species really are males, generic names, none too happily invented should be given to them, it is not easy to understand. Surely, among Ammonites, as among higher orders of beings, husband and wife should be known by the same name.

This author also treats of the group of Ammonites allied to *A. humphriesianus*, under the name *Cœloceras*. This genus he divides into males, distinguished by an "apophyse jugale," and called *Normannites*; and females, which have no such "apophyse" and are called *Cadomites*. Thus he links the following males and females:—

| | | | | | |
|---|---|---|---|---|---|
| *Cœloceras* (*Normannites*) | *bigoti* | to | *C.* (*Cadomites*) | *bigoti*. |
| ,, ,, | *sauzei* | to | ,, ,, | *polyschides*. |
| ,, ,, | *braikenridgii* | to | ,, ,, | *subcoronatum*. |
| ,, ,, | *linguiferum* | to | ,, ,, | *daubenyi*. |

The example set by Munier-Chalmas has recently been followed by E. Haug, in a paper on "Ammonites des Etages moyennes" (*Bull. Soc. Géol. France*, 3e ser., t. xx., p. 298). This author has applied the same criteria to the genus *Sonninia*, and has come to the conclusion (p. 300) that the normal *Sonniniæ* are the females, and that the group of *Sonninia sulcata*, which contains forms not unlike *Ammonites cycloides*, consists of males. He admits that the species of females far outnumber those of males, but expresses a hope that the missing husbands will eventually be found.

Let us now consider how far these somewhat extreme views, which if true would lead to great complications, are consistent with already known facts.

An objection that might strike even the casual reader of these papers is that all the Lias and much of the Inferior Oolite had been passed through before any of these so-called males appeared; for the earliest are those which Haug finds among the *Sonniniæ*. In the Ammonite fauna of the Lias we have as yet only been able to notice one species possessing the characters supposed by Munier-Chalmas and Haug to denote the male sex. That species is *Ammonites accipitris*, J. Buckman, which, as it occurs with *Ammonites oxynotus*, would be considered as the male of that species. Now *Ammonites accipitris* is, unfortunately for this hypothesis, a very rare form, which seems only to have been found in this country, and in one restricted locality. *Ammonites oxynotus*, however, is common enough on the Continent, where it must have lived in a state of single blessedness. But as for the rest of the Liassic Ammonites, where are the males? Or are we to suppose that the two sexes were exactly alike, and that secondary sexual characters were a comparatively latter-day Jurassic invention?

Objections such as these suggest the enquiry whether there may not be some other explanation of the appearances that the French authors are so ready to ascribe to sexuality. As that remarkably Heavenly Twin, Angelica Hamilton-Wells, reminds us, "so unwholesomely is the imagination of a man affected by ideas of sex."

Now the characters that Munier-Chalmas has hit upon as "masculine" are in great measure those which appear in the different Ammonite-stocks or lines of descent when they draw near the period of their extinction. They are, to a large extent, characters such as we have learned to associate with the old age of a race, when it is in a sense retrogressive. May we not then suppose that these so-called males are in reality the final expressions of the various races to which they belong? At all events, *Cadomoceras*, *Œcotraustes*, and *Œcoptychius* seem explicable as such retrogressive forms; but *Normannites* is admittedly a difficulty.

The sexual hypothesis, however, is one about which it would be foolish to dogmatise; it deserves full consideration. Munier-Chalmas and Haug say that they have many males yet unfigured; and this statement is borne out by other collections, so far as the Oolitic rocks are concerned. It must be remembered that our knowledge of the Ammonite fauna is as yet very imperfect, large though the number of described species appears to be. Some of the Jurassic rocks have been done very scant justice to, and their treasures are still unknown to Ammonite literature.

Apart, however, from any special hypothesis, there is one consideration that may profitably be brought to the notice of those who endeavour to discover signs of sex in the extinct Cephalopods. They may be recommended to enquire whether such signs are to be found in the living species of *Nautilus*, and if so, what those signs are. Of course *Nautilus* is not an Ammonite, does not even belong to the same Order of Cephalopoda; still there can be very little doubt that

the situation of the animal with regard to the shell was much the same in the Ammonites, and that any effect produced in the Ammonite shell by sexual difference would probably also be found in that of *Nautilus*.

Owing to the somewhat curious fact, which may of course be mere coincidence, that the large majority of specimens of *Nautilus* examined by eminent naturalists have been of the female sex, not much has been said upon this subject by zoologists. J. D. Macdonald, however, in his account of the anatomy of *Nautilus umbilicatus* (*Phil. Trans.*, 1855, p. 277), has a sentence which, though its logic is obscure, certainly bears on this question. He writes: "The specimen of *N. umbilicatus* examined proved to be a female, a fact which may serve to modify the views of those who, adopting the ingenious speculations of d'Orbigny with reference to the sexes of the Ammonites as indicated by the characters of their shells, apply them also to the several kinds of *Nautili* known." He appears to be alluding to the belief that the species known as *N. umbilicatus* was nothing more than the male of *N. pompilius*. Still the fact that it was really a true species, though it might upset that particular belief, would not conflict with the idea that there might be some differences between the shells of the two sexes.

An attempt to demonstrate some such difference was made in the same year by J. Van der Hoeven (*Verh. d. kon. Nederl. Akad. van Wetensch.*), who had at last obtained a male *Nautilus pompilius*. After describing various external sexual characters of the animal, he proceeds:—"It seems to me moreover as not improbable that in the shape of the hood there is a sexual distinction, and that this, when of the same average length, is about two centimetres shorter in the male individual. With this is also connected a distinction in the shape of the shell; in the male individual this is broader and more globose at the aperture, more laterally compressed in the female animal. Also the edge of the aperture of the shell in the male animal is, as it seems to me, more strongly sinuous; in the female animal more regular." It will be noted that these points of difference, assuming them to be correct, by no means agree with the suppositions of de Blainville, d'Orbigny and others with regard to Ammonites; and in such a case surely no one will venture to exclaim "So much the worse for the *Nautilus!*" Moreover, if one may judge from the drawings by A. G. Bourne which adorn Professor E. Ray Lankester's article on Mollusca in the "Encyclopædia Britannica," both the male animal and its shell are proportionately broader than the female. It is indeed by no means necessary to suppose, as did the older writers, that the swelling of the female organs involves a widening of the shell. The shell of the body-chamber must necessarily have been formed before the development of the ova, and any pressure caused by the enlargement of the soft parts must act on the soft parts themselves quite as much as on the shell. Since, however, the shell is hard

and unyielding, the obvious result of such pressure is merely to push the animal forward so that it obtains space by lengthening rather than by widening the body-chamber.

Some caution is, however, to be exercised before accepting the views which Van der Hoeven based upon the evidence of a single specimen. Differences such as he points out do certainly exist between *Nautilus* shells; but a careful examination inclines one to regard them as due to difference of age rather than of sex. As *N. pompilius* grows older, the sides of the shell-aperture begin to swell outwards, so that the width of the aperture is greater towards the inner or dorsal region of the whorl; and this produces a sinuosity in the margin, which continues to increase with age up to a certain point. May it not then be that Van der Hoeven was deceived by just the same kind of characters in the individual species as we believe Munier-Chalmas and Haug to have been deceived by in the race?

To sum up the case in language that has often been objected to in this Journal, and with which its readers cannot, therefore, be wholly unfamiliar,—we suggest that the characters in question are auxologic or bioplastic rather than sexual, being in some cases phylo-gerontic, in others merely ephebic or gerontic, and we conclude that sexual dimorphism has yet to be proved for Ammonite-shells.

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## III.

# The Palæarctic and Nearctic Regions compared as regards the Families and Genera of their Mammalia and Birds.

IN a paper read before the Cambridge Natural Science Club on March 12 (and printed in *Nature* of April 26, 1894), I discussed the question of the nature and uses of Zoological Regions, and arrived at the conclusion that, in order to secure the maximum of utility, it is essential to have only one set of regions for all groups of land animals; and, further, that the six regions established by Dr. P. L. Sclater are the most natural and convenient, and are best adapted to facilitate the comparative study of distribution, which is the main purpose for which Zoological Regions, as distinct from the ordinary geographical divisions of the globe, have been established.

These regions were at first generally adopted; but of late years many eminent naturalists, both in America and Europe, have proposed other divisions, though hardly any two of these agree with each other. The most important modification, and that which has been adopted by several zoologists both as regards mammals and birds, is to unite the Palæarctic and Nearctic Regions so as to form one new region, coextensive with the extratropical Northern Hemisphere. This new region, which has been termed the Holarctic, is said to be more nearly equal to the other regions as regards peculiar genera and families, and, therefore, to form part of a more natural and harmonious series than if we treat the two component parts as separate regions. It is this one question only that I propose to discuss in the present paper: whether the Palæarctic and Nearctic Regions, as defined by Sclater, present so many resemblances and so few differences that they can be reasonably considered to form one region as homogeneous as are most of the other regions.

The reason why so much difference of opinion exists on this point, when the very same facts are before all the enquirers, seems to be that they treat the facts in different ways. In the first place, it seems to me that far too much stress is laid upon the comparatively small number of absolutely peculiar genera or families in the two temperate

regions. That may, or may not, be a reasonable ground for deciding that the regions in question are not of equal rank with some other regions; but it cannot justify the union of the two areas unless it can be shown that they are to a large extent homogeneous—that, in fact, the resemblances are more numerous and more important than the differences. In the areas we are discussing, however, this is decidedly not the case, since the facts clearly show that the differences very far surpass the resemblances—that the former are, in fact, fundamental, and are far greater than can be found in the separate halves of any of the other regions, unless they are so divided as to be very unequal in area or to present very great differences in climate. But the Palæarctic and Nearctic Regions are, roughly speaking, equal in area, while they both exhibit the very same range of climate. Any difference that exists between them must, therefore, be due to more fundamental causes; and the most fundamental cause is, that in each case the existing fauna is descended from an ancient, equally distinct, fauna, modified in different ways by immigration from adjacent areas.

In dealing with any question of this kind, it is very important that the genera and family groups adopted shall be the same as far as possible throughout the whole area. In order to ensure this, I have, for mammalia, adopted those of Flower and Lydekker in their "Mammals Living and Extinct." In the case of the birds, I am indebted to my friend Mr. H. E. Dresser, both for completing his "List of European Birds" so as to include those of the whole Palæarctic region, and also for so harmonising his genera with those of the "A. O. U. Check List of North American Birds," as to combine the whole into a single series. As Mr. Dresser has made a study of North American birds as well as of those of the Palæarctic Region with which his name is more especially associated, the result is probably as fair and unbiased, for the comparison in question, as can be arrived at. In the case of both regions, I have rejected all those genera in which a single species only just enters the region from the adjacent region to which it properly belongs. Here, again, there is, of course, room for difference of opinion; but the doubtful cases are not sufficiently numerous to introduce any important uncertainty in the result.

For both mammals and birds I adopt the same system of presenting the facts which, after much consideration and many trials, seems to me to be the best. The families and genera are arranged in three columns—the first giving those which are Palæarctic but not Nearctic; the third those that are Nearctic but not Palæarctic; the middle column giving those which are common to the two regions—so that by combining this with either of the others we obtain the entire fauna of that region. The results are then summarised in other tables and briefly discussed. We begin with the mammals:—

## Mammals of the Palæarctic and Nearctic Regions.

| PALÆARCTIC. | BOTH REGIONS. | NEARCTIC. |
|---|---|---|
| | **Bats.** | |
| *Rhinolophidæ*: | | |
| 1. Rhinolophus. | | |
| *Vespertilionidæ*: | *Vespertilionidæ*: | *Vespertilionidæ*: |
| 2. Synotus. | 1. Plecotus. | 1. Antrozous. |
| 3. Harpyiocephalus. | 2. Vesperugo. | 2. Nycticejus. |
| | 3. Vespertilio. | 3. Atalapha. |
| | *Emballonuridæ*: | *Phyllostomidæ*: |
| | 4. Nyctinomus. | 4. Macrotus. |
| | **Insectivora.** | |
| *Erinaceidæ*: | | |
| 4. Erinaceus. | | |
| *Soricidæ*: | *Soricidæ*: | *Soricidæ*: |
| 5. Crossopus. | 5. Sorex. | 5. Neosorex. |
| 6. Crocidura. | | 6. Blarina. |
| 7. Diplomesodon. | | |
| 8. Anurosorex. | | |
| 9. Nectogale. | | |
| *Talpidæ*: | *Talpidæ*: | *Talpidæ*: |
| 10. Myogale. | 6. Urotrichus. | 7. Scalops. |
| 11. Talpa. | | 8. Scapanus. |
| | | 9. Condylura. |
| | **Carnivora.** | |
| *Viverridæ*: | *Felidæ*: | *Procyonidæ*: |
| 12. Genetta. | 7. Felis. | 10. Procyon. |
| 13. Herpestes. | | 11. Bassaris. |
| *Hyænidæ*: | *Canidæ*: | |
| 14. Hyæna. | 8. Canis. | |
| | *Ursidæ*: | |
| | 9. Ursus. | |
| *Mustelidæ*: | *Mustelidæ*: | *Mustelidæ*: |
| 15. Meles. | 10. Lutra. | 12. Latax. |
| | 11. Mustela. | 13. Mephitis. |
| | 12. Gulo. | 14. Taxidea. |
| | *Trichechidæ*: | *Otariidæ*: |
| | 13. Trichechus. | 15. Otaria. |
| *Phocidæ*: | *Phocidæ*: | *Phocidæ*: |
| 16. Halichærus. | 14. Phoca. | 16. Macrorhinus. |
| 17. Monachus. | 15. Cystophora | |
| | **Ungulata.** | |
| *Suidæ*: | | *Dicotylidæ*: |
| 18. Sus. | | 17. Dicotyles. |
| *Cervidæ*: | *Cervidæ*: | *Cervidæ*: |
| 19. Moschus. | 16. Cervus. | 18. Cariacus. |
| | 17. Rangifer. | |
| | 18. Alces. | |
| | | *Antilocapridæ*: |
| | | 19. Antilocapra. |

| PALÆARCTIC. | BOTH REGIONS. | NEARCTIC. |
|---|---|---|
| | UNGULATA.—*continued.* | |
| *Bovidæ*: | *Bovidæ*: | *Bovidæ*: |
| 20. Saiga. | 19. Ovis. | 20. Haplocerus. |
| 21. Pantholops. | 20. Bos. | 21. Ovibos. |
| 22. Gazella. | | |
| 23. Addax. | | |
| 24. Rupicapra. | | |
| 25. Budorcas. | | |
| 26. Capra. | | |
| *Equidæ*: | | |
| 27. Equus. | | |
| | RODENTIA. | |
| | *Sciuridæ*: | *Sciuridæ*: |
| | 21. Sciurus. | 22. Cynomys. |
| | 22. Tamias. | |
| | 23. Sciuropterus. | |
| | 24. Arctomys. | |
| | 25. Spermophilus. | |
| *Myoxidæ*: | *Castoridæ*: | *Haploodontidæ*: |
| 28. Myoxus. | 26. Castor. | 23. Haploodon. |
| 29. Eliomys. | | |
| 30. Muscardinus. | | |
| *Muridæ*: | *Muridæ*: | *Muridæ*: |
| 31. Gerbillus. | 27. Arvicola. | 24. Hesperomys. |
| 32. Cricetus. | 28. Myodes. | 25. Sigmodon. |
| 33. Ellobius. | 29. Cuniculus. | 26. Ochetodon. |
| 34. Siphneus. | | 27. Neotoma. |
| 35. Mus. | | 28. Phenacomys. |
| 36. Acanthomys. | | 29. Synaptomys. |
| | | 30. Fiber. |
| | | 31. Neofiber. |
| *Spalacidæ*: | | |
| 37. Spalax. | | |
| 38. Rhizomys. | | |
| | | *Geomyidæ*: |
| | | 32. Geomys. |
| | | 33. Thomomys. |
| | | 34. Diplodomys. |
| | | 35. Perognathus. |
| | | 36. Heteromys. |
| *Dipodidæ*: | | *Dipodidæ*: |
| 39. Sminthus. | | 37. Zapus. |
| 40. Dipus. | | |
| 41. Alactaga. | | |
| 42. Platyceromys. | | |
| *Hystricidæ*: | | *Hystricidæ*: |
| 43. Hystrix. | | 38. Erethizon. |
| | *Lagomyidæ*: | |
| | 30. Lagomys. | |
| | *Leporidæ*: | |
| | 31. Lepus. | |
| | MARSUPIALIA. | |
| | | *Didelphidæ*: |
| | | 39. Didelphys. |

Looking through the preceding lists, we find a remarkable divergence in the characteristic groups of the two regions. Out of fifteen genera of Insectivora, only two are common to both regions; an amount of difference which, if it occurred among larger and better known animals, would produce a striking effect of diversity. In the Carnivora there is a much smaller proportion of peculiar genera, but this is to some extent counterbalanced by each region possessing two families absent from the other. Ungulata, again, show considerable diversity, the Palæarctic Region possessing ten genera and the Nearctic five which are not found in the other. Only five genera are common to both, and of these five, two, Rangifer and Alces, are arctic, while two others, Ovis and Bos, have one species each in the Nearctic Region against about thirteen between them in the Palæarctic. The Rodents, again, have only eleven genera common to both regions, while the Palæarctic has sixteen and the Nearctic seventeen which are not found in the other region.

The following summary will enable us to see the total amount of similarity and difference:—

SUMMARY OF DISTRIBUTION.

| Orders. | | Families. | | | Genera. | | |
|---|---|---|---|---|---|---|---|
| | *No. of Genera.* | *Palæarctic.* | *Both.* | *Nearctic.* | *Palæarctic.* | *Both.* | *Nearctic.* |
| Cheiroptera .. | 11 | 1 | 2 | 1 | 3 | 4 | 4 |
| Insectivora .. | 15 | 1 | 2 | 0 | 8 | 2 | 5 |
| Carnivora .. .. | 22 | 2 | 6 | 2 | 6 | 9 | 7 |
| Ungulata .. .. | 20 | 2 | 2 | 2 | 10 | 5 | 5 |
| Rodentia .. .. | 44 | 2 | 7 | 2 | 16 | 11 | 17 |
| Marsupialia .. | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| | — | — | — | — | — | — | — |
| | | 8 | 19 | 8 | 43 | 31 | 39 |
| | | — | — | — | — | — | — |
| Total Genera .. | 113 | — | — | — | 74 | — | 70 |
| Total Families .. | | 27 | | 27 | | | |

Here we see that in both the regions the number of genera *not* found in the other largely exceed those common to both, the proportion of the total genera thus limited being 58 per cent. in the Palæarctic, and 56 per cent. in the Nearctic Region; while in each case out of a total of 27 families no less than 8 are so limited. If we compare this amount of diversity with that between the Ethiopian and Oriental Regions, we shall find that, while as regards genera it is somewhat less, as regards families it is considerably greater. In the Oriental Region out of a total of about 72 families of mammals only 8 are not Ethiopian; while in the Ethiopian region out of about 74 families only 10 are not Oriental. No doubt these two regions are those which most resemble each other, and they have been united by some naturalists, but they are now generally admitted to be sufficiently distinct to be classed as separate regions. Great weight has, however, always been given to the possession of peculiar families; and for the same reason the fact that nearly one-third of the families in the

Palæarctic and Nearctic regions respectively are *not* found in the other, indicates a fundamental diversity that renders their union into one region quite inadmissible.

We will now tabulate the birds, in which the amount of diversity is much larger as regards genera, and equally as large as regards families:—

LAND BIRDS OF THE PALÆARCTIC AND NEARCTIC REGIONS.

| PALÆARCTIC. | BOTH. | NEARCTIC. |
|---|---|---|
| *Turdidæ*: | *Turdidæ*: | *Turdidæ*: |
| 1. Monticola (4 sp.) | 1. Turdus (21.5) | 1. Merula (2) |
| 2. Myiophoneus (1) | 2. Sialia (1) (= Grandala (3) | 2. Hesperocichla (1) |
| 3. Saxicola (20) | 3. Regulus (4.3) | 3. Polioptila (3) |
| 4. Pratincola (7) | | 4. Myadestes (1) |
| 5. Ruticilla (15) | | |
| 6. Hodgsonius (1) | | |
| 7. Chimarrhornis (1) | | |
| 8. Cyanecula (2) | | |
| 9. Erithacus (4) | | |
| 10. Calliope (3) | | |
| 11. Cossypha (1) | | |
| 12. Nemura (1) | | |
| 13. Daulias (2) | | |
| 14. Sylvia (18) | | |
| 15. Melizophilus (2) | | |
| 16. Phylloscopus (19) | | |
| 17. Hypolais (8) | | |
| 18. Ædon (2) | | |
| 19. Acrocephalus (10) | | |
| 20. Lusciniola (10) | | |
| 21. Locustella (8) | | |
| 22. Cettia (4) | | |
| 23. Cisticola (1) | | |
| 24. Drymoeca (1) | | |
| 25. Scotocerca (2) | | |
| 26. Argya (3) | | |
| 27. Rhopophilus (3) | | |
| 28. Babax (1) | | |
| 29. Pterorhinus (1) | | |
| 30. Trochalopteron (2) | | |
| | *Cinclidæ*: | |
| | 4. Cinclus (4.1) | |
| *Accentoridæ*: | | |
| 31. Accentor (11) | | |
| *Panuridæ*: | | |
| 32. Panurus (1) | | |
| *Paridæ*: | *Paridæ*: | *Paridæ*: |
| 33. Leptopœcilus (2) | 5. Parus (26.6) | 5. Chamæa (12) (sub. fam.) |
| 34. Lophobasileus (1) | 6. Lophophanes (3.4) | |
| 35. Suthora (1) | 7. Acredula (7) = Psaltriparus (13) | |
| 36. Ægithalus (4) | | |
| | *Sittidæ*: | |
| | 8. Sitta (8.4) | |

| PALÆARCTIC. | BOTH. | NEARCTIC. |
|---|---|---|
| *Certhiidæ*: | *Certhiidæ*: | |
| 37. Tichodroma (1) | 9. Certhia (2.1) | |
| | *Troglodytidæ*: | *Troglodytidæ*: |
| | 10. Troglodytes (6.3) | 6. Cistothorus (2) |
| | | 7. Thryothorus (3) |
| | | 8. Catherpes (1) |
| | | 9. Salpinctes (2) |
| *Motacillidæ*: | *Motacillidæ*: | 10. Harporhynchus (8) |
| 38. Motacilla (16) | 11. Anthus (14.2) | 11. Galeoscoptes (1) |
| 39. Limodromus (1) | | 12. Mimus (1) |
| | | 13. Oroscoptes (1) |
| *Crateropodidæ ?* | | *Mniotiltidæ*: |
| 40. Zosterops (2) | | 14. Mniotilta (1) |
| *Oriolidæ*: | | 15. Protonotaria (1) |
| 41. Oriolus (2) | | 16. Helenaia (1) |
| | | 17. Helmitherus (1) |
| | | 18. Helminthophila (8) |
| | | 19. Compsothlypis (2) |
| | | 20. Dendroica (24) |
| | | 21. Sciurus (3) |
| | | 22. Geothlypis (6) |
| | | 23. Icteria (1) |
| | | 24. Sylvania (3) |
| | | 25. Setophaga (2) |
| | | 26. Cardellina (1) |
| *Muscicapidæ*: | *Laniidæ*: | *Vireonidæ*: |
| 42. Muscicapa (6) | 12. Lanius (22.2) | 27. Vireo (12) |
| 43. Hemichelidon (1) | *Ampelidæ*: | *Ampelidæ*: |
| 44. Alseonax (1) | 13. Ampelis (2.2) | 28 Phainopepla (1) |
| 45. Xanthopygia (3) | | |
| *Hirundinidæ*: | *Hirundinidæ*: | *Hirundinidæ*: |
| 46. Chelidon (3) | 14. Hirundo (3) (= Chelidon (1) | 29. Progne (1) |
| | | 30. Petrochelidon (1) |
| | 15. Cotile (3) (= Clivicola (1) | 31. Tachyniceta (2) |
| | | 32. Stelgidopteryx (1) |
| | | *Tanagridæ*: |
| | | 33. Piranga (4) |
| *Fringillidæ*: | *Fringillidæ*: | *Fringillidæ*: |
| 47. Carduelis (2) | 16. Chrysomitrus (2) = Spinus (4) | 34. Rhyncophanes (1) |
| 48. Serinus (4) | | 35. Poocetes (1) |
| 49. Chloris (3) | 17. Coccothraustes (1.1) | 36. Ammodramus (11) |
| 50. Passer (8) | 18. Linota (7) = Acanthis (2) | 37. Chondestes (1) |
| 51. Eophona (2) | | 38. Zonotrichia (6) |
| 52. Pycnorhamphus (1) | 19. Carpodacus (10.4) | 39. Spizella (7) |
| 53. Petronia (2) | 20. Pinicola (1.1) | 40. Junco (7) |
| 54. Montifringilla (7) | 21. Loxia (5.2) | 41. Amphispiza (2) |
| 55. Fringilla (6) | 22. Plectrophanes (2) = Calcarius and Plectrophenax (5) | 42. Peucæa (5) |
| 56. Fringalauda (1) | | 43. Melospiza (4) |
| 57. Bucanetes (4) | | 44. Passerella (1) |
| 58. Uragus (2) | 23. Leucosticte (5.3) | 45. Pipilo (6) |
| 59. Pyrrhula (7) | | 46. Cardinalis (1) |
| 60. Urocynchramus (1) | | 47. Habia (2) |
| 61. Emberiza (32) | | 48. Guiraca (1) |

| PALÆARCTIC. | BOTH. | NEARCTIC |
|---|---|---|
| | | *Fringillidæ—(continued)* : |
| | | 49. Passerina (4) |
| | | 50. Spiza (1) |
| | | 51. Calamospiza (1) |
| | | *Icteridæ* : |
| | | 52. Dolichonyx (1) |
| | | 53. Molothrus (1) |
| | | 54. Xanthocephalus (1) |
| | | 55. Agelaius (3) |
| | | 56. Sturnella (1) |
| | | 57. Icterus (6) |
| | | 58. Scolecophagus (2) |
| | | 59. Quiscalus (3) |
| *Alaudidæ* : | *Alaudidæ* : | |
| 62. Certhilauda (2) | 24. Otocorys (4.1) | |
| 63. Galerita (3) | | |
| 64. Alauda (3) | | |
| 65. Ammomanes (2) | | |
| 66. Calandrella (6) | | |
| 67. Melanoscorypha (6) | | |
| 68. Rhamphocorys (1) | | |
| *Sturnidæ* : | | |
| 69. Sturnus (4) | | |
| 70. Pastor (1) | | |
| 71. Poliopsar (1) | | |
| 72. Sturnia (2) | | |
| *Corvidæ* : | *Corvidæ* : | *Corvidæ* : |
| 73. Podoces (4) | 25. Nucifraga (1) = Picicorvus (1) | 60. Cyanocitta (2) |
| 74. Pyrrhocorax (2) | 26. Perisoreus (1.2) | 61. Aphelocoma (3) |
| 75. Garrulus (9) | 27. Pica (2.2) | 62. Cyanocephalus (1) |
| 76. Cyanopica (2) | 28. Corvus (11.5) | |
| | | *Tyrannidæ* : |
| | | 63. Milvulus (1) |
| | | 64. Tyrannus (4) |
| | | 65. Myiodynastes (1) |
| | | 66. Myiarchus (3) |
| | | 67. Sayornis (3) |
| | | 68. Contopus (4) |
| | | 69. Empidonax (7) |
| | | 70. Pyrocephalus (1) |
| | | 71. Ornithion (1) |
| *Cypselidæ* : | *Cypselidæ* : | *Cypselidæ* : |
| 77. Acanthyllis (1) | 29. Cypselus (7) = Micropus (1) | 72. Cypseloides (1) |
| | | 73. Chætura (2) |
| *Caprimulgidæ* : | | *Caprimulgidæ* : |
| 78. Caprimulgus (4) | | 74. Autrostomus (2) |
| | | 75. Phalænoptilus (1) |
| | | 76. Chordeiles 1) |

| PALÆARCTIC. | BOTH. | NEARCTIC. |
|---|---|---|
| | | *Trochilidæ*: |
| | | 77. Eugenes (1) |
| | | 78. Cœligena (1) |
| | | 79. Trochilus (8) |
| | | 80. Iache (1) |
| *Picidæ*: | *Picidæ*: | *Picidæ*: |
| 79. Dryocopus (2) | 30. Picus (18) = Dryobates (5) | 81. Campephilus (1) |
| 80. Gecinus (6) | 31. Picoides (1.2) | 82. Xenopicus (1) |
| 81. Ingipicus (3) | | 83. Sphyrapicus (3) |
| 82. Jynx (1) | | 84. Ceophlæus (1) |
| | | 85. Melanerpes (5) |
| | | 86. Colaptes (4) |
| *Alcedinidæ*: | *Alcedinidæ*: | |
| 83. Alcedo (1) | 32. Ceryle (2.2) | |
| 84. Halcyon (2) | | |
| *Coraciadæ*: | | |
| 85. Coracias (2) | | |
| *Meropidæ*: | | |
| 86. Merops (3) | | |
| *Upupidæ*: | | |
| 87. Upupa (1) | | |
| *Cuculidæ*: | | *Cuculidæ*: |
| 88. Cuculus (4) | | 87. Coccyzus (2) |
| 89. Hierococcyx (2) | | 88. Geococcyx (1) |
| 90. Coccystes (1) | | 89. Crotophaga (1) |
| | | *Psittacidæ*: |
| | | 90. Conurus (1) |
| | *Strigidæ*: | |
| | 33. Strix (1.1) | |
| *Bubonidæ*: | *Bubonidæ*: | *Bubonidæ*: |
| 91. Ninox (1) | 34. Asio (1.2) | 91. Speotypo (1) |
| 92. Athene (3) | 35. Syrnium (4) = Ulula (3) | 92. Micrathene (1) |
| | 36. Nyctea (1.1) | |
| | 37. Surnia (2.1) | |
| | 38. Nyctala (1.2) | |
| | 39. Scops (4) = Megascops (2) | |
| | 40. Bubo (4.1) | |
| | 41. Glaucidium (1.1) | |
| *Vulturidæ*: | | *Cathartidæ*: |
| 93. Gyps (2) | | 93. Pseudogryphus (1) |
| 94. Vultur (1) | | 94. Cathartes (1) |
| 95. Neophron (1) | | 95. Catharista (1) |
| 96. Gypaetus (1) | | |
| *Falconidæ*: | *Falconidæ*: | *Falconidæ*: |
| 97. Circaetus (1) | 42. Circus (6.1) | 96. Elanoides (1) |
| 98. Nisaetus (2) | 43. Buteo (5.7) | 97. Ictinia (1) |
| 99. Milvus (4) | 44. Archibuteo (2.2) | 98. Parabuteo (1) |
| 100. Pernis (1) | 45. Aquila (7.1) | 99. Urubutinga (1) |
| | 46. Haliætus (3.1) | 100. Polyborus (2) |

| PALÆARCTIC. | BOTH. | NEARCTIC |
|---|---|---|
| | *Falconidæ—(continued)*: | |
| | 47. Astur (2.1) | |
| | 48. Accipiter (4.2) | |
| | 49. Elanus (1.1) | |
| | 50. Falco (17.8) | |
| | 51. Pandion (1.1) | |
| *Columbidæ*: | *Columbidæ*: | *Columbidæ*: |
| 101. Turtur (8) | 52. Columba (14.3) | 101. Ectopistes (1) |
| | | 102. Zenaidura (1) |
| | | 103. Columbigallina (1) |
| | | 104. Scardafella (1) |
| *Pteroclidæ*: | | |
| 102. Pterocles (6) | | |
| 103. Syrrhaptes (2) | | |
| *Phasianidæ*: | | *Phasianidæ*: |
| 104. Phasianus (17) | | 105. Meleagris (1 |
| 105. Pucrasia (2) | | |
| 106. Chrysolophus (2) | | |
| 107. Crossoptilon (5) | | |
| 108. Lophophorus (1) | | |
| 109. Ithaginis (3) | | |
| 110. Caccabis (5) | | |
| 111. Francolinus (2) | | |
| 112. Perdix (4) | | |
| 113. Coturnix (2) | | |
| 114. Tetraophasis (2) | | |
| 115. Tetraogallus (5) | | |
| *Tetraonidæ*: | *Tetraonidæ*: | *Tetraonidæ*: |
| 116. Tetrastes (3) | 53. Lagopus (5.4) | 106. Colinus (3) |
| 117. Tetrao (5) | 54. Canachites (2)= Dendragapus (3) | 107. Oreortyx (2) |
| | | 108. Callipepla (3) |
| | | 109. Cyrtonyx (1) |
| | | 110. Bonasa (1) |
| | | 111. Tympanuchus (2) |
| | | 112. Pediocetes (1) |
| | | 113. Centrocercus (1) |
| *Turnicidæ*: | | |
| 118. Turnix (3) | | |

By merely glancing over these lists we see at once how greatly the genera in either the first or third column exceeds those in the middle column. This tells us that the speciality of each region in relation to the other is very much greater than their similarity. In order, however, to bring out these differences and resemblances more clearly, and to show what they imply, the facts are summarised in the following table of the families, giving the distribution of their genera and species in the same order as in the preceding lists:—

FAMILIES OF NORTH TEMPERATE LAND BIRDS WITH THEIR DISTRIBUTION AS REGARDS THE PALÆARCTIC AND NEARCTIC REGIONS.[1]

| Total Genera. | Families. | PALÆARCTIC ONLY. Genera. | Species. | BOTH REGIONS. Genera. | Species. | NEARCTIC ONLY. Genera. | Species. |
|---|---|---|---|---|---|---|---|
| 37 | Turdidæ .. .. | 30 | 185 | 3 | 0 | 4 | 18 |
| 1 | Cinclidæ .. .. | — | 4 | 1 | 0 | — | 1 |
| 1 | Accentoridæ .. | 1 | 11 | | | | |
| 1 | Panuridæ .. .. | 1 | 1 | | | | |
| 8 | Paridæ .. .. | 4 | 44 | 3 | 0 | 1 | 14 |
| 1 | Sittidæ .. .. | — | 8 | 1 | 0 | — | 4 |
| 2 | Certhiidæ .. | 1 | 3 | 1 | 0 | — | 1 |
| 9 | Troglodytidæ .. | — | 6 | 1 | 0 | 8 | 22 |
| 3 | Motacillidæ .. | 2 | 31 | 1 | 0 | — | 2 |
| 13 | Mniotiltidæ .. | | | | | 13 | 54 |
| 1 | Vireonidæ .. | | | | | 1 | 12 |
| 1 | Crateropodidæ ? .. | 1 | 2 | | | | |
| 1 | Oriolidæ .. .. | 1 | 2 | | | | |
| 1 | Laniidæ .. .. | — | 22 | 1 | 0 | — | 2 |
| 2 | Ampelidæ .. | — | 1 | 1 | 1 | 1 | 2 |
| 4 | Muscicapidæ .. | 4 | 11 | | | | |
| 7 | Hirundinidæ .. | 1 | 9 | 2 | 1 | 4 | 7 |
| 1 | Tanagridæ .. | | | | | 1 | 4 |
| 41 | Fringillidæ .. | 15 | 110 | 8 | 5 | 18 | 79 |
| 8 | Icteridæ .. | | | | | 8 | 18 |
| 8 | Alaudidæ .. | 7 | 26 | 1 | 1 | — | 1 |
| 4 | Sturnidæ .. | 4 | 8 | | | | |
| 11 | Corvidæ .. | 4 | 30 | 4 | 2 | 3 | 14 |
| 9 | Tyrannidæ .. | | | | | 9 | 25 |
| 4 | Cypselidæ .. | 1 | 8 | 1 | 0 | 2 | 4 |
| 4 | Caprimulgidæ .. | 1 | 4 | — | — | 3 | 4 |
| 4 | Trochilidæ .. | | | | | 4 | 11 |
| 12 | Ficidæ .. .. | 4 | 31 | 2 | 0 | 6 | 22 |
| 3 | Alcedinidæ .. | 2 | 5 | 1 | 0 | — | 2 |
| 1 | Coraciadæ .. | 1 | 2 | | | | |
| 1 | Meropidæ .. | 1 | 3 | | | | |
| 1 | Upupidæ .. | 1 | 1 | | | | |
| 6 | Cuculidæ .. | 3 | 7 | — | — | 3 | 4 |
| 1 | Psittacidæ .. | | | | | 1 | 1 |
| 1 | Strigidæ .. | — | 1 | 1 | 0 | — | 1 |
| 12 | Bubonidæ .. | 2 | 18 | 8 | 4 | 2 | 11 |
| 4 | Vulturidæ .. | 4 | 5 | | | | |
| 3 | Cathartidæ .. | | | | | 3 | 3 |
| 19 | Falconidæ .. | 4 | 51 | 10 | 5 | 5 | 26 |
| 6 | Columbidæ .. | 1 | 22 | 1 | 0 | 4 | 7 |
| 2 | Pteroclidæ .. | 2 | 8 | | | | |
| 13 | Phasianidæ .. | 12 | 50 | — | — | 1 | 1 |
| 12 | Tetraonidæ .. | 2 | 14 | 2 | 1 | 8 | 20 |
| 1 | Turnicidæ .. | 1 | 3 | | | | |
| 285 | (44 Families.) | 118 | 747 | 54 | 20 | 113 | 397 |
| Total in each Region .. | | 172 | 767 | | | 167 | 417 |

[1] It must be noted that the numbers in the "Species" columns represent the *species* which are absent from the other region, *not* the number of species contained in the "genera" of the preceding column, which are the genera absent from the other region.

The following statement, giving statistics derived from the preceding lists, will complete the information necessary for a comparative view of the relations of the Palæarctic and Nearctic Regions as regards their land-birds :—

The Palæarctic Region has **36** families of land-birds.
Of these, **12** families are not in the Nearctic Region.
These **12** families comprise **22** genera and **57** species.

The Nearctic Region has **32** families of land-birds.
Of these, **8** families are not in the Palæarctic Region.
These **8** families comprise **40** genera and **128** species.

The **118** Palæarctic genera which are not Nearctic comprise **472** species.
The **113** Nearctic genera which are not Palæarctic comprise **282** species.

The preceding lists and figures enable us to obtain a very complete view of the amount of difference that exists between the avifaunas of the Palæarctic and Nearctic Regions.

Considering first the Family groups, we find that in the one case **one-third** and in the other **one-fourth** of the families of the one region are not found in the other; and this is an amount of difference that does not occur between any other two regions which are conterminous with each other. The most striking relation of the Palæarctic and Nearctic Regions is, therefore, not their resemblance, but their dissimilarity.

Again, the **12** families which thus differentiate the Palæarctic Region from the Nearctic comprise **22** genera and **57** species; and among them we find such characteristic groups of the Eastern Hemisphere as the accentors, the flycatchers, the starlings, the vultures, and the sand-grouse,—families entirely absent from the whole Western Hemisphere.

The **8** families which differentiate the Nearctic Region from the Palæarctic are even more important, since they contain **40** genera and **128** species; and include such characteristic New World types as the Mniotiltidæ, the Icteridæ, and the Tyrannidæ, containing between them nearly a hundred species. Now as there are only **417** species of land-birds in the whole Nearctic Region, we find that between **one-third** and **one-fourth** of the whole belong to *families* which are entirely foreign to the Palæarctic Region. It may be confidently asserted that none of the other regions can be so divided that the two parts shall show an amount of difference at all approaching to this. Yet it is proposed to unite these two regions because they are not sufficiently distinct. They are, however, very much more distinct than are the Ethiopian and Oriental Regions, though the former includes the isolated and peculiar Madagascar fauna. Less than **one-twelfth** of the Ethiopian families of land-birds are not Oriental, while only **one-ninth** of the Oriental families are not

Ethiopian; showing that, by this test of the number of families which are not found in both regions, the Palæarctic and Nearctic are three times as distinct as are the Ethiopian and Oriental Regions.

If we now consider the genera which are characteristic of the one region as compared with the other, we shall find equally strong evidence of their diversity. In the Palæarctic Region we have **120** genera which are not Nearctic, out of a total of **174**; so that a little more than **two-thirds** of the Palæarctic genera of land-birds are quite unknown in the Nearctic Region; and these genera contain **472** species out of a total of **767**. In other words, out of every **5** land-birds in the Palæarctic Region, **3** belong to *genera* which are **not** Nearctic.

Looking at the same problem from the other side of the Atlantic, the results are even more striking. Out of a total of **167** genera of Nearctic land-birds no less than **113** are not Palæarctic, the proportion being almost exactly **two-thirds.** These **113** genera comprise **282** species out of a total of **417** species; so that again almost exactly **two-thirds** of the Nearctic land-birds belong to *genera* which are not Palæarctic. This is a larger proportion than in the case of the Palæarctic Region; and nothing can more forcibly bring before us the fundamental diversity of the two areas than the fact that, almost everywhere in the Nearctic Region, out of every **three** birds we might meet with, **two** would be generically unknown to the student of the Palæarctic avifauna. There is probably no such amount of difference as this between any two adjacent regions, except perhaps between the Oriental and Australian, the latter admittedly the most isolated on the globe.

I have now shown, by a careful comparison of their mammalia and birds, that the Palæarctic and Nearctic Regions, instead of being so much alike that they should be united to form a single region, are really exceptionally distinct. They are certainly much more distinct than are the Oriental and Ethiopian Regions, and are probably quite as distinct as are any two conterminous regions.

I feel confident, therefore, that any naturalist who will study the materials I have here brought together in a form to admit of easy comparison, will arrive at the conclusion that the system of Zoological Regions established by Dr. Sclater cannot be improved by the union of two such fundamentally distinct areas as are those which he has termed the Palæarctic and Nearctic Regions.

ALFRED R. WALLACE.

## IV.

# Some Current Problems in Experimental Psychology.

RECENT notes in NATURAL SCIENCE and in *Nature* seem to indicate that England is at last awaking to the fact that experimental psychology—which is an endowed science over practically the whole continent of Europe, and throughout the United States of America—has some claims upon her attention. It may not be amiss, at the present juncture, to put together a rough list of the problems most prominently upon the carpet; more especially as the statement of them may serve to dispel certain wrong ideas, as to the scope and subject-matter of the new discipline, which are unhappily prevalent in extra-psychological circles.

But first, as to definitions. *Psychophysics* is the science of the relation of "mind" to "body." *Experimental Psychology* is just psychology; the science which describes "mental" processes, and enumerates their conditions. The experimental method is not intended to oust introspection; accurately controlled introspection is experiment, and experiment is introspection made scientifically valuable, *i.e.*, universally valid. *Physiological Psychology* is an experimental psychology pursued by physiological methods, and with constant reference to the "physical substrate of mind." It is, therefore, narrower than experimental psychology proper, in that its methods are more restricted: it is wider than experimental psychology, in that it admits of the psycho-physical reference, which does not obtain in psychology as such.

It is often said, whether by way of reproach or merely as fact, that experimental psychology is primarily or exclusively the psychology of sensation. But the truth or falsehood of such a statement depends altogether on the definition of sensation. (1) Some psychologists (like Münsterberg) regard "sensation" as the one ultimate constituent of mind. For them, "psychology" is, of course, equivalent to "doctrine of sensation." Only their use of the term must not be confused with the usage of physiology and of opposed schools of psychology. (2) Others (like Külpe) posit a two-fold basis of mind: sensation and affection (=pleasure - pain). (3) Others, again (like Sully), make every psychosis triple; its three

elements being sensation, affection (=pleasure - pain), and conation (effort or activity).[1] Those who adopt the views of (2) or (3) have protested, and must continue to protest, against the restriction of their science to the description of and theorising upon a single psychical ultimate. And as more authors are drawn from their ranks than from those of (1), and the literature of affection and conation is quite extensive, while the term "sensation" tends to be used, even by psychologists of the first type, in its more narrow and usual sense, it would seem that the objection stated at the beginning of this paragraph can only be accounted for by the assumption of ignorance of general psychological literature on the part of those who raise it.

Still, there is no smoke without fire. How did the erroneous opinion arise in the first place? There are several reasons that might be alleged. (i.) An experimental psychology must logically begin with (technical[2]) sensation (*cf.* Wundt, *Vorlesungen*, 2nd ed., pp. 14, 15). (ii.) Chronologically, it did so begin. (iii.) Sensation-investigations tend to be assigned as theses for University degrees, because they are easier than are investigations into affection, conation, or the more complex mental processes. (iv.) This greater easiness is partly conditioned by a fact which deserves special mention: that language is the language of sensation and its derivatives; not of affection, conation, and their derivatives. For these processes gesture-language is the only direct means of communication. All spoken or written communication of them first translates them into terms of sensation and idea. (v.) There are, on the lowest estimate, over 50,000 irresolvable qualities of sensation. There are only two of affection, and only one of conation. Hence, even if sensations are grouped into modalities, the psychological literature of sensation must be far more bulky than that of affection and conation. (vi.) Physiologists—who have done much good service to experimental psychology, and service all the more valuable so long as psychology remained or remains without endowment—know, as a rule, a great deal about sensation, but little either of the literature of the other two claimants for recognition as conscious ultimates, or of that of concrete psychology (the "higher" mental processes). Other reasons might doubtless be added to these.

I have (1) not attempted to arrange the following rough list of current investigations. Indeed, classification would be impossible except in terms of a committal psychology. For the difference between the old and the new psychologies here is just this: that the old drew their parallel columns, and headed them "Intellect," "Feeling," and "Will"; while the new, however many or few the ultimates which it postulates, regards every complex psychosis as

[1] I omit, for brevity's sake, the various sub-forms of these views.

[2] "A sensation is that simple, conscious process which stands in a relation of dependence to definite nervous organs at periphery and centre." — Külpe, *Grundriss*, p. 30.

containing in it every elementary process, in greater or less degree. In place of the parallel columns is set a criss-cross of connecting lines. And though the scheme is generally accepted, the directions and number of the lines are still (as has been indicated above) matters of individual conviction. (2) Neither is the list to be considered as in any sense exhaustive. Investigations of elementary questions (of the intensity, quality, temporal and spatial relations of sensations, affections, conditions) are not included in it. And there are, doubtless, many recent investigations of compound processes which do not receive mention.

Those to which I desire to call attention are the following:—

(1.) *Recognition.*—The problem of direct and indirect recognition has been the subject of a good deal of discussion during the last few years. In his *Grundriss der Psychologie*, Külpe (*a*) propounds a new theory on the basis of experimental work done, and (*b*) indicates the path of future experimentation.—*Cf.* also an article on *Reproduction* in the *Philosophical Review*.

(2.) *Fluctuations of Attention.*—It is well known that we can attend to an unchanging impression only for a very short time. The suggestion had been made that this phenomenon was peripherally conditioned by fatigue of the sense-organ. A series of articles in the *Philosophische Studien* shows that the fluctuations are of central origin, and rehabilitates attention as a conscious process involving other than sensational elements.

(3.) *The Modes of Combination of Conscious Elements.*—(*a*) *Fusion.* The best account, theoretical and experimental, of Fusion is to be found in Külpe's *Grundriss*. Articles have been published at intervals since the appearance of the second volume of Stumpf's *Tonpsychologie*. Sensation-fusion is one of the most promising fields for experimentation now open. (*b*) *Association.* Articles on ideational association, in part based on Scripture's investigation in the *Philosophische Studien*, have appeared in *Mind*, *The Psychological Review*, *The American Journal of Psychology*. Emotional association is treated briefly in Lehmann's *Hauptgesetze*. Here, too, experiments are badly needed.—*Cf.* also (1), above.

(4.) *Memory.*—An elaborate monograph, on the basis of Ebbinghaus' *Das Gedächtniss*, has appeared in the *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*.

(5.) *Rhythm and Subjective Accentuation.*—See *The American Journal of Psychology*, and an unfinished series of papers in the *Philosophische Studien*.

(6.) *Action* (= idea + voluntary act; a disparate association).—Some contributions have been made in the American journals to the analytic psychology of the simple reaction.

(7.) *The Psychological Basis of Visual Aesthetics.*—Two articles on Fechnerian lines (*i.e.*, dealing with the aesthetics of form) have been published in the *Philosophische Studien*.

To these may be added the following, as investigations rather suggested or begun, than in any sense concluded:—

(8.) *The Intensifying Effect of Attention.*—Does attention intensify its own content, or merely inhibit other content?

(9.) *Apperceptive Completion.*—Within what limits do we overlook misprints, complete faulty stroboscopical images, etc.?

(10.) *The Influence of Visual upon Tactile Space.*—How far is a space judgment in cutaneous terms possible?

(11.) *Mental Fatigue.*—*Cf.* the *Amer. Journ. of Psych.*, the *Zeits. f. Psych.*, etc.

(12). *The Psychological Basis of Visual Aesthetics.* (Content.)

However incomplete, within the lines laid down for it, this list may be, it will at least serve its double purpose: it will indicate the nature of some of the current problems in experimental psychology, and prove that that science is not simply the science of sensation. It takes no account of recent work in social psychology, psychogenesis, mental pathology, or animal psychology.

E. B. TITCHENER.

V.

# Notes on Ground-Ice.

EVERY student of geological text-books and many observers of nature must be aware of the fact that ice sometimes forms on the bottom of running streams, instead of on the top, as invariably happens with standing water. Sixty years ago the knowledge of this fact seems to have been almost confined to the unlearned, and its reality was denied by the natural philosophers of the day; it has now become one of the elementary facts of physical and geological science alike, and is only doubted by some few, like Mr. Leslie in his charming "Letters to Marco," who, though keen observers of nature, make no pretence to be regarded as scientific authorities.

The subject is referred to in every text-book of geology, principally from the point of view of the action of this form of ice in modifying the shape of the earth's surface, and the question of its mode of origin is treated in a more or less imperfect, where not inaccurate manner. The standard account, to which reference is often made, was published in 1833 by Arago,[1] whose paper is principally devoted to a proof of the reality of the phenomenon, which appears at that time to have been generally regarded as incompatible with the fundamental laws of nature. The theory advanced by him was that, owing to the swirls and eddies of the current, the whole body of the stream is reduced to freezing point,[2] and that in this water the stones and weeds on the bottom serve as so many nuclei for the ice crystals to form upon.

Within two years of the publication of this theory a totally different one was broached,[3] and supported by some careful and instructive observations. According to this the formation of ground-ice is due to loss of heat by radiation from the stones on the bottom, which are thus cooled below freezing point, and so give rise to the growth of ice crystals in a manner analogous to the formation of hoar frost.

These two are the theories found, in one form or another, in nearly every text-book, and of them the latter appears to enjoy the greater

[1] *Annuaire du bureau des Longitudes*, 1833, pp. 244–268.

[2] *See* Desire Leclerq, *Mem. Cour. Acad. Roy. Bruxelles*, vol. xviii. (1845), forob servations confirmatory of this.

[3] J. Farquharson, *Phil. Trans.* vol. cxxv., 329–343 (1835).

popularity, a result probably of its greater ease of comprehension, as much as of the observations to which it was conjoined. There are, indeed, certain facts which seem to support this theory, such as the general consensus of observers that ground-ice is only produced in clear water, and on cloudless nights, when radiation is most active; and Mr. Farquharson in his paper lays stress on the fact that it was not found near the piers of a bridge, close to an embanking wall, or under a grass-clad bank. This is, however, explicable in other ways than by radiation having been checked by these objects, and as regards the first part of the argument the coincidence may well be due to the fact that sharp frosts seldom occur in temperate latitudes except in cloudless weather, while the clearness of the water is as much a necessity of the first-named theory as a support of the second. Moreover, if there were any truth in the assumption, that the clear water of a stream flowing over a stony bottom is cooled to any important extent by radiation from the stony bottom over which it flows, this would be equally true in the case of standing water. But such we know is not the case, and it is the fact that the loss of heat takes place principally from the surface of the water, combined with its expansion and consequent decrease of density as the freezing point is approached, that makes our ponds freeze first on their upper surfaces.

Against the other theory, that the pebbles on the bottom merely act as nuclei on which the ice crystallises out from water cooled down below freezing point, it might be urged that this cannot occur with water such as is met with in nature, but only after it has been distilled or otherwise cleared of all dissolved air and solid particles. This, however, is not altogether the case. I have myself observed the cooling of water below freezing point when no special precautions had been taken. While camping in the desert of Western Rajputana it was a common experience to find, after a clear and cloudless night in January and February, that the water in my wash-hand basin was frozen over, and frequently frozen solid. On one occasion, after a cold night, I was surprised to find that the water was unfrozen, and, thinking that perhaps the night had not been so cold as I imagined—I had not then examined my thermometer—I plunged my hands into the water, which immediately became converted into a pasty mass of ice crystals and water. Here ordinary well water, in a basin which was only clean in the common sense of the word, had cooled below freezing point without solidifying; but the occurrence was an exceptional one, and it may well be doubted if it could take place as an ordinary event in the waters of a stream.

There is yet a third theory, originally published in 1816,[4] which appears to have been almost completely lost sight of since, that ground-ice is due to the presence of numerous minute crystals of ice in the ice-cold water; these are carried to the bottom of the stream

[4] T. A. Knight, *Phil. Trans.*, 1816, pp. 286–293.

by the eddies, and there, coming into contact with stones and weeds, are collected and frozen together into a tangled mass of spongy ice. It is probable that ice crystals are always present when ground ice is being formed, they are specifically mentioned by Knight,[5] by Eisdale,[6] who thought that they originated in the air and then fell into the water, and by Rae,[7] while the only observation which my limited opportunities have enabled me to make, tends to show that the accumulation of small ice crystals independently formed in the water of the stream is a most important factor in the production of ground-ice.

In May, 1888, I was encamped at Karzok, on the shores of the Tso Moriri, at an elevation of close on 15,000 ft. above the sea. The camp was pitched on the edge of a small oasis of cultivation, and the irrigation channel, which supplied the fields, flowed not far from the door of my tent. The night had been a cold one, and in the morning, while the ground was still hard with frost, I noticed that the water in the irrigation channel had risen and overflowed its banks; as this water was derived from the melting of snow on the hills, it should have been at its lowest in the early morning, and the rise of the water during the night made me look for the cause of so unexpected an occurrence. I found that a sheet of semi-opaque, whitish ground-ice had formed on the bottom of the channel and so raised the level of the water, and that the ice was still growing. As the depth of the channel was under a foot, the process was an easy one to observe, and I was able to notice that the water was full of minute crystals of ice, which were swept along by the current, and, coming into contact with the surface of the ice on the bottom, became entangled in the irregularly disposed crystals of which it was composed and frozen into one solid mass with them. Owing to a diversion of the stream, consequent on its rise of level, I was also able to observe the gradual formation of a continuous sheet of ice. At first the ice crystals accumulated against stones and weeds in the bed, and principally on the up-stream side, as was observed by Knight in 1816; but as the numerous small local clusters of crystals grew in size they coalesced to form a continuous sheet with an irregularly-mammilated upper surface.

From these observations it would seem that the earliest theory proposed comes so near the truth that the neglect it has met with is not justified. The crystallising out of water reduced to or slightly below freezing point is doubtless a cause, and may in some case be the most important one in the formation of ground-ice; but the process is aided to a much larger extent than is generally recognised by the entanglement and accumulation of ice crystals formed and floating in the water.

R. D. OLDHAM.

[5] *Phil. Trans.*, 1816, p. 286.
[6] *Edin. New Phil. Journ.*, vol. xvii., 167–171 (1834).
[7] *Nature*, vol. xxi., 538 (1889).

## VI.

# The Significance of the Bird's Foot.

TO say that birds have been evolved from reptiles is to utter one of the tritest of zoological commonplaces; but as to the nature of the particular reptilian stock which blossomed out into birds, there is by no means a complete accord among zoologists. Some have suggested a connection between the birds and the pterodactyles: a connection which, if it ever existed, must have done so before either class obtained the power of flight. For it is hardly possible that animals which had developed the pterodactyl form of flying organs would then proceed to change them into feathered wings. Others, led away by the resemblances between the *Ratitæ* and the ornithopodous *Dinosaurs*, have traced the pedigree of flying fowl from the latter through the former. But the striking resemblances between the feet of these groups may, in all probability, be set down as produced by similar needs and conditions, especially since both have the same reptilian origin. For even in mammals we find a very bird-like hind-limb, with coalesced metatarsals, in the Jerboa, which walks in the same manner as a bird when not performing its prodigious leaps. Conversely, there is a strong superficial resemblance between the hind-limbs of an ostrich and a horse.

Even Professor Fuerbringer, however, thinks that the first birds were probably terrestrial, afterwards diverging into climbers on rocks and trees, and inhabitants of swampy regions, the latter stock giving rise to waterfowl.

It is not without considerable diffidence that I venture to propose a different theory, namely, that birds originated from an arboreal reptile, which had acquired tree-haunting habits before it began to develop wings, and that all terrestrial and aquatic forms of bird-life can be derived from arboreal ancestors.

If we survey the various divisions of the vertebrates, we shall find, almost invariably, that the first steps towards flight are taken by already arboreal forms. Such forms, taking short flights by means of a skinny parachute, are found among reptiles, in the "flying" geckos (*Ptychozoon*), and the "flying" dragons (*Draco*). Among mammals, we may cite the "flying" Sciuridæ, the Anomalures, and especially *Galeopithecus*, which, with its interfemoral membrane and long webbed fingers, plainly indicates the way in which the bats probably

developed. The latter animals, possessing true flight—in fact, they are the most aërial of all vertebrates—still show, in their tree- and rock-frequenting habits, and activity in climbing, traces of their scansorial ancestor. In mammals, in this way, we can trace an almost complete transition from a terrestrial to an aërial life, the intermediate stage being spent in the trees.

It will, however, doubtless be objected, that the flying-fish are the animals which present the nearest approach to true flight among the parachutist vertebrates. Indeed, after watching these creatures, one is inclined to agree with Pettigrew, that they really do fly for short distances; and we know that the power of flight is in some birds quite limited.

Darwin, also, points out that there is no difficulty in imagining that it might be of advantage to a penguin-like bird, first to flap along the surface of the water like the logger-head duck (*Micropterus*), and ultimately to rise in the air.

But against this it may be urged that aquatic animals do not tend towards complexity of epidermic clothing, as witness the hairless *Cetacea* and *Sirenia*; so that it is difficult to see how feathers, those most complex of epidermic structures, could have arisen on an aquatic animal. Besides which, I hope to be able to show that the evidence is all in favour of aquatic birds being descended from terrestrial, as indicated above, and not *vice versâ*. This brings me to the point contained in the title of this paper. The avian foot is, in its way, almost as characteristic as the fore-limb; and its typical form is one adapted, by its backwardly-directed hallux, for grasping boughs. This form is found in *Archæopteryx*, and in many important existing groups, to wit, Passeres, Pigeons, and Herons, and other modifications may easily be derived from it. Thus, *zygodactylous* birds become so by a gradual shifting backwards of the fourth digit, a change which is apparently still in process in the owls, which always perch in the *zygodactyle* position. An analogous turning back of the second toe gives the *heterodactylous* foot of the trogons. As this backwardly-directed hallux is unnecessary for terrestrial and aquatic birds, we find in these a tendency towards its disappearance; and in some groups the process can be traced .Thus, in the Gallinæ we find the Curassows and Megapodes with a well-developed thumb, while in the terrestrial game-birds it is small, elevated, and almost functionless; indeed, I have noticed that domestic fowls, when roosting, turn the hallux forwards. It is noteworthy that the Megapodes, with their grasping feet, also display the reptilian character of hatching their eggs otherwise than by incubation, and the young emerge from the shell in an almost adult condition. Similarly, among the *Anseres*, we find that in *Anseranas*, where the webs of the feet are least developed, the hallux is well-developed and incumbent, whereas the rest of the family show it in a nearly or quite functionless condition. Likewise those archaic Anseriformes, the

Screamers, combine with their slightly-webbed feet a normal hallux, so that in this group there is a fairly clear indication of a transition from semi-arboreal land-birds to waterfowl, which may help to explain the tree-nesting habits of many of the ducks, such as *Dendrocygna*, *Aix*, *Clangula*, etc.

Among birds of the family Limicolæ, the hallux is on the point of disappearance; in many plovers it is absent, and where present very small and useless. Among the gulls, which are usually considered as offshoots of the terrestrial Limicoline stock, though usually present in a functionless condition, this toe is on the very point of disappearance in the common Kittiwake (*Rissa tridactyla*), some individuals of which species have it, while others have only a mere tubercle. Here, again, it is noteworthy that *Dromas*, probably a connecting link between Gulls and Plovers, and therefore presumably more archaic than either, exhibits semi-palmate feet with a fair-sized posterior toe.

The arboreal pigeons have a typical grasping foot, while in their terrestrial relatives the Sandgrouse it is disappearing, being quite absent in the highly-specialised *Syrrhaptes*.

Few important groups exist in which the hallux is entirely wanting, the most noteworthy among Carinates being the Bustards; but the affinities of these to hallux-possessing forms are obvious. In many birds usually regarded as tridactylous, subcutaneous vestiges of the missing toe are to be found, notably in some Woodpeckers and Albatrosses, thus actually proving what is easily inferred, that the toe has disappeared in these forms. It is noteworthy that in almost every case where a hallux appears at all, it retains to the last its posterior direction, thus showing its original function. This may be seen even in some Ratitæ, *e.g.*, in *Apteryx*.

The exceptions to this rule may usually be easily explained. The forwardly-directed first toe of some Swifts is obviously a special adaption, as also are the versatile halluxes of the Coliidæ and Goatsuckers; while the hallux of the Steganopodes, often stated to be turned forward, really has an inward or backward direction, and functions in perching in the ordinary way, as anybody may observe in living birds. These birds are, still, less attached to the water than most aquatic birds, and their semi-arboreal habits have no doubt descended to them directly from an ancestry which they share with the Herons.

It may be argued that many arboreal birds may have been originally terrestrial, just as certain geese (*e.g.*, *Cereopsis*) have left the water for the land. But we know that terrestrial life leads sooner or later to a reduction of the toes, and that the hallux is the first to disappear in almost every case, so that it would have had to be re-acquired to fit a ground-dweller for a life in trees—and there is, as Garrod has already pointed out, no reason to believe that an organ originally lost is ever reproduced.

And even the highly-specialised and pre-eminently arboreal Passeres are evolving terrestrial forms in the Larks, waders in the Wagtails, and even waterfowl in the Dippers—none of which have as yet had time to lose the typical foot of their order; and thus avian history is repeating itself.

It would seem, therefore, that this highest group of birds is, in virtue of its habitat and foot-structure, in reality one of the most primitive. And this is paralleled among the Mammalia by the pentadactylous condition of the otherwise highly-organised Primates.

If, then, as I hope, I have given reason to believe that the arboreally-adapted form of foot is the one we should naturally expect to find in the ancestors of the birds, this feature gives, I think, an additional claim to *Archæopteryx* to be regarded as one of those ancestors, rather than as a side-branch of the avian tree.

Its teeth, the free and clawed digits of its hands, and its long tail without pygostyle, fulfil the requirements of a schematic primitive bird, and if its grasping feet may be added to the design, we may fairly say that in the Solenhofen fossils we have a creature which stands as nearly as possible upon the central line of avian development in past ages.

FRANK FINN.

# SOME NEW BOOKS.

## The Monograph on Salpa.

The Genus Salpa. A Monograph, with 57 plates. By W. K. Brooks, Ph.D., LL.D., Professor in the Johns Hopkins University. Memoirs of the Biologica Laboratory of the Johns Hopkins University, II. Baltimore: The Johns Hopkins Press, 1893.

Salpa is itself so interesting an animal and belongs to so interesting a group that the results of Professor Brooks's researches deserve at once a fuller and a less technical account than is given usually in a review. The account need not be technical, for all morphologists who take a special interest in the Tunicates will have to pore over this magnificent memoir. Even to those who pay no special attention to them, the Tunicates are interesting because they seem to possess, more certainly than any other group, indications that they represent the stock from which the vertebrate animals were derived. But in addition to this general interest, Dr. Brooks has brought before us matter so surprising that it may well attract the notice of all who care for the problems of nature.

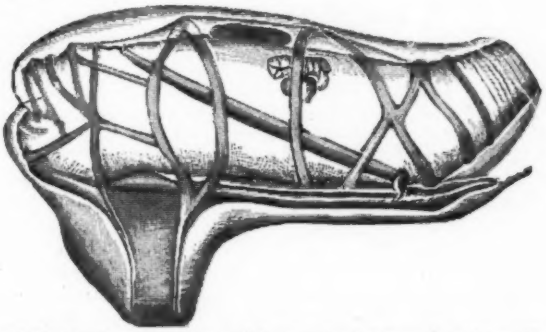

Fig. 1.—*Salpa pinnata:* a specimen of the aggregated form seen from the left side.

*Salpa* is a transparent swimming Tunicate, which may be compared to a barrel, open at both ends. It is, in fact, an enormous Pharynx which swims through the water, gulping great mouthfuls at every contraction of its muscles. A rod-like gill stretches from above the wide open mouth in front, through the hollow of the barrel, to below the posterior aperture behind; but this is so narrow that it offers no obstruction to the flow of water through the animal. Along the ventral line of the inside of the barrel runs a ciliated, mucus-secreting band, which is the homologue of the endostyle in ascidians and *Amphioxus*. At the posterior end of the barrel, in a thick mass, are contained the viscera, and this mass is the only part of the animal which is not transparent. Representing the hoops of the barrel are a number of muscular bands by the contraction of which the water is driven through

the body. The whole animal is surrounded by a thick, tough, transparent "mantle."

The food of *Salpa* consists of minute organisms like diatoms, radiolarians, and so forth, and as these are practically unlimited in quantity on the ocean surface where *Salpa* lives, *Salpæ* are often found swarming in numbers beyond description. They vary in size from a quarter of an inch to eight inches. Though most abundant in the tropics, they are found from further north than Scotland and Norway to beyond Cape Horn and the most southerly parts of Australia. "They are abundant," says Dr. Brooks, "only after the water has been for some time undisturbed by winds: and as prolonged calms are most frequent in warm seas, these waters are most favourable for the development of these animals, which multiply with most astonishing rapidity. The smaller species are often so abundant that for hundreds of miles any bucketful of water dipped up at random, will be found to contain hundreds of them. In such places collecting with the surface net becomes impracticable, for almost as soon as the net is dropped into the water, it becomes choked with a mass so that nothing can enter it."

Since the time of the poet and naturalist Chamisso, it has been known that there are two generations in the life cycle of *Salpa*. These are a generation of solitary individuals, and a generation of

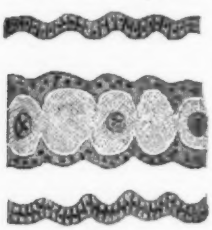

FIG. 2.

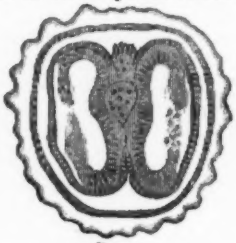

FIG. 3.

FIG. 4.

FIG. 2—Chain of germ-cells surrounded by follicle-cells, lying in a blood canal.
FIG. 3.—Section through a young embryo.
FIG. 4.—Fertilised egg-cell surrounded by follicle-cells.

individuals aggregated into chains or clusters. The specific characters of the two generations differ from each other so widely, that without rearing them there is no possibility of determining which simple and solitary forms belong to each other. The solitary *Salpa* is born from an egg which is carried within the body of the aggregated *Salpa*, and the embryo, by means of a nutritive placenta, is nourished during its development from the blood of the aggregated form. The aggregated *Salpæ* are produced asexually by budding from a stolon within the body of the solitary form. The eggs arise at an exceedingly early stage in the development of the animal. Thus the curious result happens that three generations are simultaneously present in the same animal. A solitary *Salpa* contains a developing chain of the individuals of the aggregated form, and within these are already present the eggs which are to give rise to the next generation of solitary forms. Actually, the germ-cells can be seen in a solitary form before the stolon is visible which is to give rise to the generation of individuals in which the germ-cell will develop. As the stolon forms, it includes within it the mass of germinal cells; and as the stolon elongates to form the chain of individuals, the mass of germ-cells also elongates and becomes pulled out, so that a single egg-cell is shut off in each individual of the aggregated series. This chain of eggs is enclosed in a chain of follicle-cells, as in Fig. 2, which,

however, does not show the ventral band of thick epithelium which ultimately gives rise to the testes. From these follicle cells short fertilising ducts grow out to the wall of the cloaca of each individual of the chain. Through these ducts fertilisation takes place, and each salp of the chain thus comes to contain a fertilised egg, which is to give rise to a solitary individual. In Fig. 1 is shown an individual of the chain-salp of *Salpa pinnata*, with the developing embryo attached to the wall of the cloaca. The egg and the embryo in its youngest stages are really outside the wall of the cloaca, in one of the blood sinuses of the chain-salp, but attached to the cloaca by the fertilising duct which opens into the cloaca. As the embryo grows it pushes into the wall of the cloaca, without, however, breaking through, and so becomes suspended in a sac, which is really the in-pushed wall of the cloaca, and which opens into the blood sinus. This sac remaining open to the blood sinus of the chain-salp, expands considerably, and becomes the placenta, by which the embryo continues to get its nourishment from the blood of the chain. The edge of the cloaca, round the place where the embryo is pushing in, grows in as a double fold, the hollow between the layers of which is, of course, in continuity with the blood space in which the embryo was formed. This double fold comes to form a special sac, the amnion or embryo-sac, which opens into the cloaca by a small pore, the space left by the edges of the fold not completely meeting each other. Thus a horizontal section cut through, such an embryo as hangs into the cloaca in Fig. 1, would pass first through the outer wall of the amnion, next through the blood space, thirdly through the inner wall of the amnion, fourthly through the brood-pouch, which is part of the cloaca of the chain-salpa, next through the epithelial capsule, then through the embryo (*see* Fig. 3). The embryo-sac, however, does not increase in size, and the growing embryo rapidly pushes itself through the small pore, and comes to hang directly into the cloaca.

Within these complicated membranes a process of a most astonishing nature has been going on. The fertilised egg-cell was at first surrounded by a layer of follicle-cells, which, themselves being derived from the germinal cells, differ from the egg only in not being actually developed into mature eggs and becoming fertilised (Fig. 4). The egg-cell divides slowly, the follicle-cells divide rapidly, and many of them push their way in towards the centre of the mass, and actually push apart those cells which result from the division of the egg-cell. During this time constant migration of nuclei takes place from the ingrowing follicle-cells to the cells which have come from the egg-cell. No doubt this is a process of nutrition, not very different in kind from some known methods, although it is at least curious to find nuclear matter being added from an extrinsic source to the developing embryo. If it be remembered that most now believe that the nucleus of a fertilised embryo is derived equally from the nuclei of the male and female generative cells, that this nuclear matter is the bearer of the inherited qualities of the embryo, and that by subsequent assimilation and growth it gives rise to the entire nuclear matter of the new organism, then it will be sufficiently astonishing to find the nuclear matter of any cells serving simply as nutritive material. But, if this is difficult to understand, what is to be said of the other process, by which the embryo is, so to say, broken in pieces during its development? For what else is the separation of the segmentation spheres by the intruding follicle-cells? Driesch and Wilson have shown cases where the separation of the first two spheres by artificial means resulted in the formation of twin embryos.

Here is a natural parallel, with the remarkable difference that not many embryos, but only a single embryo comes from the separate pieces, which, after pursuing for a time a separate course, re-unite. But more astonishing matter remains. The actual embryo is first blocked out in follicle-cells.

"These form layers and undergo foldings and other changes which result in an outline or model of all the general features in the organisation of the embryo. While this is going on, the development of the blastomeres is retarded, so that they are carried into their final positions in the embryo while in a very rudimentary condition. Finally, when they have reached the places which they are to occupy, they undergo rapid multiplication and growth, and build up the tissues of the body directly, while the scaffolding of follicle-cells is torn down and used up as food for the true embryonic cells."

"An imaginary illustration may help to make the subject clear. Suppose that while carpenters are building a house out of wood that brickmakers pile clay on the boards while they are carried past, and shape the lumps of clay into bricks as they find them scattered through the building where they have been carried with the boards. Now, as the house of wood approaches completion, imagine that brickmakers build a brick house over the wooden framework, not from the bottom upwards, but here and there wherever the bricks are to be found, and that as fast as parts of the brick house are finished the wooden one is torn down. To make the analogy complete, however, we must imagine that all the structure which is removed is assimilated by the bricks, and is thus turned into the substance of new bricks to carry on the construction."

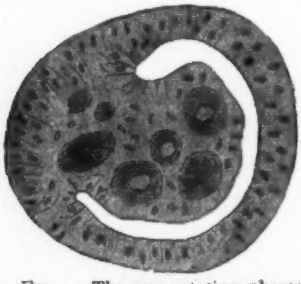

FIG. 5.—The segmentation spheres lying in a mass of follicle-cells that have grown in between them.

Fig. 5 shows a stage where the cells resulting from the early divisions of the egg-cell have been separated by the intruding follicle-cells. Figures showing the outlining of the embryo by the follicle-cells would be too complicated to reproduce without elaborate explanation and colouring, as in the beautiful illustrations of Dr. Brooks's monograph. But it must be repeated that, down to details like the structure of the nervous system, this system of preformation in follicle-cells occurs. The fate of all the structures formed of follicle-cells is the same. They degenerate, forming food for the true embryonic cells. Former observers had described something like this. Salensky, for instance, stated that the embryo of *Salpa* began as a true embryo, but afterwards the accessions from the follicle wall turned the embryo into a bud. He believed, therefore, that its development was to be compared in no way with ordinary embryological processes. Dr. Brooks considers that, however abnormal, it is a true embryo, and the appearance of budding is illusory. Certainly his figures bear out this view completely.

Dr. Brooks believes that comparative embryology has established that the ancestors of all the Tunicates once possessed small eggs with little or no food-yolk, and that these small eggs divided completely, giving rise first to a mulberry-shaped mass and then to a hollow sphere of cells. By the inpushing of the cells at one point they gave

rise to a little two-walled sac or gastrula. In many groups of vertebrates this simple form of development becomes impossible; for the egg-cell becomes so loaded with inert food-yolk that it does not divide completely, but the shape of the embryo is modified precisely in proportion to the amount of food-yolk present. The yolk is not distributed in the same way in all the animals possessing it. In some

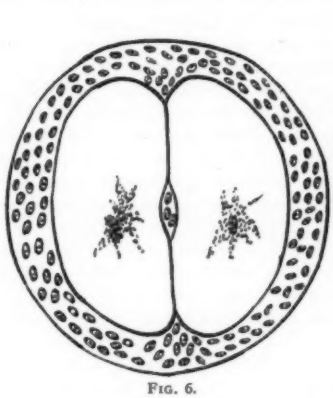

FIG. 6.

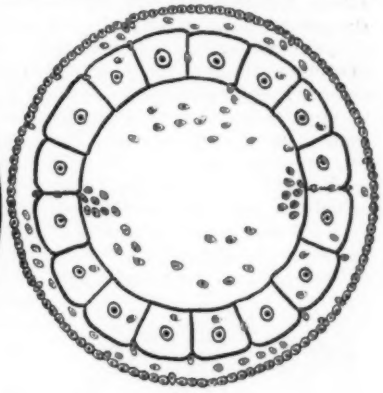

FIG. 7.

FIG. 6.—Egg of *Distaplia*: the first division has occurred, and follicle-cells are growing in between the segmentation spheres.

FIG. 7.—Diagram of a blastosphere where follicle-cells are passing into the segmentation cavity.

cases it is restricted chiefly to the cells which are to form the alimentary canal. In others, as anyone who has examined a young tadpole must know, all the cells are packed with yolk-spheres. In *Pyrosoma*, a near ally of *Salpa*, there is a large amount of food-yolk, and that is massed not in the future digestive-cavity but in the body-cavity. But the food-yolk is aided by follicle-cells, which push their way into the developing cells and are absorbed by them. Dr. Brooks suggests a method by which the peculiar arrangement in *Salpa* might

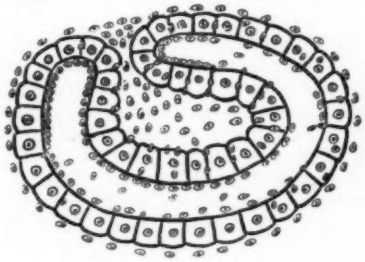

FIG. 8.

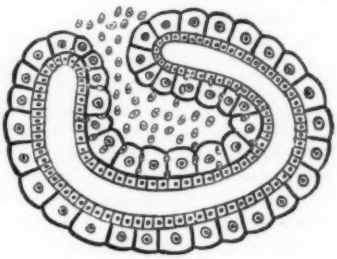

FIG. 9.

FIG. 8.—Diagram of invagination in an embryo such as that of Fig. 7.

FIG. 9.—Diagram of the gastrula of an embryo in which the follicle-cells form an epithelium.

have come about. Fig. 6 represents an actual stage in the development of *Distaplia*, which has cells bloated with food-yolk, but still able to divide completely. Two segmentation spheres are represented, surrounded by a number of follicle-cells, some of which are pushing their way in between the segmentation spheres, and which are absorbed as

food. Fig. 7 represents an imaginary stage in the development of a form which has lost food-yolk, and which, in consequence, has a large hollow segmentation cavity into which follicle-cells are migrating from the layer of follicle-cells surrounding the embryo. In Fig. 8 is represented the invaginating stage of such an embryo. The follicle-cells are, of course, inside the segmentation cavity, but they also follow the invagination, and fill the hollow that usually forms the digestive tract. Now in Fig. 9 is represented a similar stage, but in a case where the follicle-cells, instead of migrating irregularly, arrange themselves as a regular epithelium. In it is to be seen the ordinary invaginate gastrula, but the cells derived from the follicle arrange themselves as a regular cast of this. In subsequent development it is easy to see that the follicular epithelium might follow all the developments and changes of the real embryonic cells, so that each fold of tissue would be formed not only of embryonic cells, but of follicle-cells closely adherent. Dr. Brooks supposes that *Salpa* had such a history, and that, when this condition of things was reached, the development of the embryonic cells began to lag behind the development of the follicle-cells, which originally merely followed the course of the cells they came to anticipate. In Fig. 10 is shown the case of an embryo in which the invagination has taken place in follicle-cells, but where the real embryonic cells are so delayed that they appear merely as scattered segmentation spheres, and this last figure is merely a diagrammatic representation of what actually occurs in *Salpa*, as may be seen by comparison with Fig. 5.

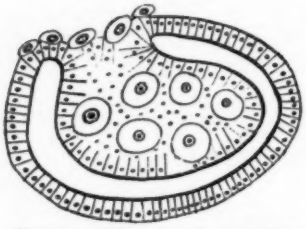

FIG. 10.—Diagram of an embryo in which the segmentation spheres delay development.

There has already appeared in NATURAL SCIENCE, vol. iii., p. 223, a brief account of the interesting views to which the development of *Salpa* has led Dr. Brooks. As that account was based on three chapters of this monograph which appeared separately, it is necessary now only to remind readers that Dr. Brooks has come to the interesting conclusion that a simple pelagic form, of which *Appendicularia* is the nearest living representative, is the common ancestor of the Ascidians and the Chordates; and that consequently there can be only among such organs as are found in simple transparent, surface-living creatures any homologies between vertebrates and invertebrates; arguments linking annelids, crustacea, and so forth with vertebrates, because of similarities in segmentation, body-cavity, etc., are dismissed as empty shadows of morphological dreams.

In this short attempt to bring to the notice of the general scientific public some of the more interesting results of Dr. Brooks' work, it has been impossible to touch upon many of the more complicated and technical matters which all specialists will have to study with attention in this great contribution to scientific literature.

## FERNS.

THE STUDY OF THE BIOLOGY OF FERNS BY THE COLLODION METHOD, for advanced and collegiate students. By G. F. Atkinson, Ph.B. 8vo. Pp. xii. and 134. New York: Macmillan & Co., 1894. Price 8s. 6d. nett.

THE author, who is associate professor of cryptogamic botany in Cornell University, Ithaca, N.Y., was led to the preparation of this

work by the success which attended his efforts in applying in his classes the "collodion method" to the preparation of the very delicate tissues of ferns, and especially to the infiltration of prothallia, without shrinkage. The first part of the book, occupying nearly three-fourths of the whole, is descriptive, and is an account of the history of development and anatomy of Ferns in the limited sense of the homosporous leptosporangiate Filicinæ. It is profusely illustrated by admirable figures, all reproduced from preparations made by the author or his pupils by the method referred to, and serving at the same time as a first-class recommendation of that method. Chapter I. deals with the gametophyte, from the germination of the spore to the fertilisation of the archegonium; while the sporophyte is the subject of the five following chapters. Chap. II., on the embryo, contains a very fine figure (fig. 49) of the young embryo of *Adiantum concinnum*. In Chapters III. and IV. the morphology and anatomy of the stem, root, and leaves are illustrated, while Chapters V. and VI. form a valuable contribution to our knowledge of the structure of the sporangium in the different families and their manner of dehiscence, with the distribution of the spores. Under '*Substitutionary Growths*' (Chap. VII.) we find an account of the development of the buds or bulbils on the pinnules or in the axils of the leaf of Aspleniums and other ferns where sporophytic budding occurs. Part I. concludes with a chapter on the Ophioglosseæ, which are introduced, not because of any near relation to the Filices, but because fresh material is easily procurable, while its members present excellent subjects for comparative study.

Part II., *Methods*, comprises notes on technique (preparation of the collodion, etc.), and hints for the preparation, infiltration, sectioning, fixing and examination of the prothallia and other organs of which the structure or development is to be studied.

The book is not a large one, considerable space is given to figures, and the text is not crowded; it is, therefore, not exhaustive, but merely an admirable and readable illustration of what has been done, and done well, by a certain method, and a guide to further work on the same lines. The general appearance of the book is quite up to Messrs. Macmillan's standard, and when we remember that every one of the 163 figures is new, the price cannot be considered exorbitant.

### Flowering Plants.

An Introduction to Structural Botany (flowering plants). By D. H Scott, M.A., Ph.D., &c. 8vo. Pp. xii. and 288, with 113 figures. London: A. & C. Black, 1894. Price 3s. 6d.

This book, which "is intended as a first guide to the study of the structure of plants," forms a new departure in elementary botanical works. It stands out from the ever-increasing crowd of guides, text-books, and manuals in virtue not only of originality of design, but also of the fact that the subjects treated have been specially investigated for the purpose of the book, so that we have not the mere compilation of a book-man, but an account based on the results of the author's own observation. Three plants, the wallflower, white lily, and spruce-fir, are selected as illustrating respectively the dicotyledonous, monocotyledonous and gymnospermous types of seed-plant, and in as many chapters the author gives us a clear, well-arranged, and concise account of their external characters, the structure of the stem, leaf, root, flower, fruit, and seeds, and the development of the reproductive organs and embryo. There is also a shorter chapter on

the physiology of nutrition. When the student has honestly worked through these chapters and seen, with the help of a competent teacher, a good series of preparations illustrating the various points of anatomy, etc., he will be well-grounded in structural botany, and ready for more detailed study and investigation, with the further advantage of having nothing to unlearn. The importance of the practical demonstration of structural features is insisted on in the preface, and with good reason, as the excellence of the figures might tempt the teacher to dispense with a microscope, especially as his sections will probably often be inferior to those so ably drawn by Mrs. Scott. Many of the figures are new, a welcome change from the well-worn "after Sachs"; several good ones have been borrowed from Strasburger; and Payer's diagrams illustrating the development of the flower of the wallflower and lily have been successfully reproduced by process. Almost the only feeble one is the last, a seedling of *Picea*, and after Kerner too! Messrs. Black have made a valuable addition, well produced in handy form, to their list of scientific publications.

## GEOGRAPHICAL DISTRIBUTION OF PLANTS.

MANUEL DE GEOGRAPHIE BOTANIQUE. Par Dr. Oscar Drude, traduit par Georges Poirault, et revu et augmenté par l'auteur, avec 4 cartes en couleurs, et 3 figures dans le texte. Livraisons 2, 3. 8vo. Pp. 49–128. Paris: P. Klincksieck, 1893. Price of each part, 1 fr. 25. Subscription price, to complete work (12 or 13 parts), 15 francs.

IN reviewing the first part of this translation and re-edition, which appeared last June, we commended the idea and also the italicised notice in the advertisement which stated that *the parts would rapidly succeed each other*. This promise has not been very well kept, which seems a pity, as there can be no doubt as to the value of the work.

In parts 2 and 3 now to hand, Section III., on biological varieties of organisation determined by geographical and topographical factors, which is an account of forms and zones of vegetation, brings us to the end of the first part of the book, and we proceed on page 40 to the second, in which the author brings together evidence to prove that the areas now occupied by plants have been determined by geological evolution, by the superficial structure of the globe, and by climate. The tendency to dispersive migratory power, the development of special floras or faunas as the result of geographical isolation, are considered, and insular floras and those of high mountain chains and deserts adduced in evidence.

Insular floras supply proof also of the date of issue of parts 2 and 3, which is given on the cover as 1893. On page 114, however, we find a reference to a review of the subject by Mr. Hemsley, which, as correctly stated in a foot-note, appeared in *Science Progress* in March of the present year. We trust that there may be no delay in subsequent issues to necessitate such falsification of date.

## LICHENS.

A MONOGRAPH OF LICHENS FOUND IN BRITAIN, BEING A DESCRIPTIVE CATALOGUE OF THE SPECIES IN THE HERBARIUM OF THE BRITISH MUSEUM. By the Rev. James M. Crombie, M.A., F.L.S., &c. Part I. 8vo. Pp. viii., 519, with 74 figures in the text. London: Printed by order of the Trustees, 1894.

THE ordinary person, or even the botanist who is not a lichenologist, will marvel at the number of British Lichens, and the more when

he is reminded that the present volume is concerned with only half of the known British species. The remainder of the work, Mr. Carruthers tells us in a prefatory note, is so advanced that it may be expected to appear next year, and will contain a complete index to all the genera and species. The re-arrangement of the group in the Herbarium of the British Museum, and the incorporation of a great number of specimens, showed the necessity of a revised catalogue, while the extensive series, including a large number of authentic specimens from the principal workers, supplied material, in many cases unique, for determining species and geographical distribution in the British Isles. The book, which is systematic, and nothing else, is well arranged, and forms a valuable addition to the list of British Museum catalogues, as well as to the literature of Lichens.

Considering the extreme technicality of the descriptions, the glossary is somewhat inadequate, and we hope Mr. Crombie will see his way to make it more complete in the second volume. In the case of common species it seems hardly necessary to give in addition to the distribution the localities of all the specimens in the British Museum (which, we presume, is the meaning of *B. M.*, though it is not so stated); we think the space might be used to better purpose for more illustrations; figures are a great help to the proper understanding of descriptions, and the seventy-four provided is not a large number for so important a work, and so difficult a group. A good morphological introduction embodying the latest views and the results of modern research on these interesting little plants, the nature of which has been the subject of so much discussion, would have made the work more complete, and increased its value.

## The Birds of Norway.

Bird Life in Arctic Norway. By Robert Collett, Foreign Member, Z.S., Professor of Zoology in the University of Christiania. Translated by A. H. Cocks, M.A., F.Z.S. 8vo. London: R. H. Porter, 2s. nett.

Ornithologists owe a debt of gratitude to the author of this charming essay, and scarcely less to its very competent translator, for the graphic pictures of northern bird life which it brings before them in a cheap and serviceable form. It was a happy thought that inspired Professor Collett to publish a Norwegian edition of his original essay (read before the second International Ornithological Congress at Buda-Pesth in May, 1891), since his own countrymen cannot fail to appreciate the value of his arduous labours in the elucidation of Scandinavian zoology; but it would have been a decided misfortune if the circulation of this essay had been limited to the Continent. Mr. A. H. Cocks has himself an enviable knowledge of boreal bird life, and his translation of his friend's work has been accomplished with a skill and accuracy that merit the highest praise. The preface supplies a tersely-written description of the physical features of Northern Norway, which will be acceptable even to those of us who have spent some of our happiest days in rambling over the mountain wastes included in this too brief survey. Professor Collett considers that Arctic Norway should be studied in three natural divisions, (1) the coast district and the belt of islands girding the coast up to North Cape; (2) the deep fjords of the Arctic Ocean and the adjacent river basins in East Finmark; (3) the interior plateaux of Finmark. The first chapter supplies a picturesque sketch of the

breeding habits of several species of sea-fowl, which will be perused with none the less pleasure if the details supplied are already familiar to the majority of readers. The woodcuts of the young of *Alca torda*, *Fratercula arctica*, and *Rissa tridactyla* are quite gems in their own way, being admirably executed. The staff of the Museum at Tromsö come in for some well-deserved recognition, while Professor Collett reminds us of the salient features of bird life on the pretty little island which gives its name to the capital of Finmark. Everywhere is heard, he says, the wild cry of the Fieldfare (*Turdus pilaris*); in every meadow we commonly find a pair of Blue-headed Wagtails (*Motacilla flava*); from the thickets in the gardens, and from the willow bushes in the moister places may be heard the best songster of the Arctic district, the Blue-throated Warbler (*Cyanecula suecica*); Redwings and White Wagtails, Bramblings and Mealy Redpolls are equally characteristic of this region. The second chapter deals with bird life on the Porsanger Fjord, which affords Professor Collett an excuse for detailing the habits of the lovely little Red-necked Phalerope (*Phalaropus hyperboreus*). "Often they may be found in flocks on the sea far from land, rocking upon the surface in the strongest swell, like small specks of foam. But in the small tarns up in the interior of the country, between the leaves of *Comarum*, *Menyanthes*, and *Hippuris*, we may be able to find their nest, or meet with the four delicately-formed, brownish-yellow, young in down, being conducted by one of the parents among the water plants. This one of the parents is, as is well known to the majority of my readers, always the male. With the utmost indifference to danger, he runs, anxiously screaming, directly in front of our feet, to divert our attention from the eggs or the small young. The females on the contrary, which are a little larger, and purer coloured, keep themselves to themselves during the nesting season, and generally form the little flocks which we have seen floating about on the small pools of water, or in the sea close to shore, far removed from the burden of family life. Here the plainly-coloured male is the weaker sex, which must wholly and entirely undertake the hatching of the eggs, and the bringing up of the young. This trait is by means peculiar to this species, although hardly in any other case to so great an extent as the present, where it also takes expression in the colour of the male. It is more or less conspicuous with most of our arctic waders of the Stint and Sandpiper families." Many other paragraphs are equally to the point, and will be read with keen enjoyment by every-one. Before taking leave of Professor Collett's delightful pamphlet, which we lay aside with unfeigned regret, it is only right that attention should be drawn to the brief, but important, appendix furnished by Mr. A. H. Cocks at the suggestion of Mr. Sclater. Herein we find an admirable list of the Birds of Norway, very properly arranged in accordance with the rules of the B.O.U. The total number of birds, we are told, hitherto found in Norway is 278, while no fewer than 212 species have nested, or are believed to have nested, in that country. But, although the number of breeding species is so large, the number of non-breeding visitors is only estimated at 66; of these, no fewer than 40 are accidental visitors—a curious contrast to the avifauna of Great Britain. In view of a second edition being required, as we trust it speedily may be, we would suggest to Mr. A. H. Cocks the extreme desirability of supplying some details of the supposed occurrence of such rare visitants as Barrow's Goldeneye (*Clangula islandica*) and the Greater Shearwater (*Puffinus major*). If the occurrence of these species in Scandinavia is really fully authenticated,

there should be no reserve in withholding the particulars from British naturalists, to many of whom the transactions of foreign societies are inaccessible.

H. A. Macpherson.

### For Beetle-hunters.

L'Amateur des Coléoptères. Par Henri Coupin. Bibliothèque des Connaissance Utiles. Pp. viii., 352, 217 figures. Paris: J. B. Baillière & Fils, 1894.

This is a very good, practical book. It opens with a chapter describing the various implements for the capture of beetles and giving instructions for their use. The British entomologist will, perhaps, get some comfort from the fact that his French co-worker, like himself, needs to be warned to ignore the rude remarks "des petits paysans" on his equipment and pursuits. A list of the principal families of beetles follows, with notes on the food, habits, and localities of each. A short account of their structural characters might, we think, have been added, with advantage to the reader. Then follow nineteen chapters, each devoted to some special locality for collecting; we have directions for "la chasse sous les pierres," "dans les jardins," "au bord de la mer," "dans la maison," "dans les animaux putréfiés" (an inviting locality), etc. The beetles which the collector is likely to find in each habitat are mentioned, and figures are given which will enable him to make out many of the common species. This method of treatment by localities is fresh and attractive; the worker will soon feel the need of a systematic treatment of the subject, but this, we feel sure, is a result aimed at by the author. The habits of many genera are noticed, and we are specially glad to remark that the author directs the attention of the beginner to the collection and study of larvæ and pupæ. Some coleopterists seem to ignore the fact that the beetles are metabolous insects.

These chapters on collecting are followed by one upon the preservation and arrangement of the collection. The author recommends phenic acid, if used with care, as a reliable preservative for the cabinet. He advises collectors not to mount their insects touching the drawer-bottom except for purposes of exchange with Englishmen; we are glad to think that this fashion is passing away amongst us, and that our continental comrades would now find the insects in our best collections well raised on the pins. The final chapter is devoted to "les collections picturesques." The author gives examples, with figures, of the ornamental necklaces, etc., which South American and other tribes make from the elytra of brilliant tropical beetles. He wishes that Europeans would follow the example of these savages, and make use of metallic beetles "dans les élégances féminines." Some of us would rejoice at this if there were any hope that it would stop the slaughter of birds for millinery.

### For Mr. William Sikes.

Habitual criminals will turn with interest to the report on the best means available for their identification, which has just been issued by H.M. Stationery Office at a price (10d.) calculated to put it within the reach of the most unsuccessful. Mr. Francis Galton's method of identification through the impressions of the finger-tips is regarded as the most scientific and accurate, and is recommended for the final test in each case. But, owing to the difficulty of classifying a very

large collection of such impressions for the purpose of ready reference, it is suggested that the primary classification of prisoners should depend on measurements of the length and breadth of the head, the length of the left middle finger, of the left forearm, and of the left foot. The Committee are strongly of opinion that it is essential to the complete success of the registry to secure the services of an expert practised in the methods of scientific anthropometry, and, if possible, one who has had practice in training other persons in making scientific measurements. A scientific adviser would be required and would be able to settle such questions as the limits to be adopted in England for the classes of large, medium, and small, and the amount of variation to be allowed for in individual measurements; he would be able to superintend the training of warders in taking measurements, and he would instruct the officers in charge of the registry in the decipherment and classification of finger-prints. He might also be able, after experience of the working of the scheme, to suggest modifications. On every ground, then, the Committee think it desirable that the English Anthropometric Office should, from the first, have the advantage of scientific guidance not inferior to that which the French Service d'Identification enjoys in having M. Bertillon at its head.

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IN the "Revue de Géographie," Paris (Jan., 1894), M. J. Girard has a paper on the Mouths of Rivers, dealing especially with modifications in form due to the velocity of the water, deposition of sediments, and waste or growth of banks. In the same number, and continued from December, Professor Malotet writes on the sandy plain of French Flanders.

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MR. EDWARD STANFORD has just issued a new edition of his "London Atlas of Universal Geography." The maps of Europe, England, Scotland, and Ireland, and Switzerland, have been redrawn, a fine sheet map of London has been added, and the following maps are new: Channel Islands, Canaries and Madeira, Asia Minor, and the Euphrates Valleys, north-west frontier of India and the Pamirs, Siam, Madagascar, Argentine Republic, and New Guinea. The atlas is too well known to need any recommendation, and, containing 100 maps, is published at £12.

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WE have received from Mr. Welch, 49 Lonsdale Street, Belfast, a catalogue of photographs of Irish views of geological interest. Several of these photographs have been taken at the suggestion of Professor Grenville Cole and Mr. M'Henry, who have supplied the geological information given in the catalogue. The photographs are issued as platinotypes or silver prints, and can be had in three sizes.

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MESSRS. FRIEDLÄNDER & SOHN, 11 Carlstrasse, Berlin, N.W., by request of the German Zoological Society, have in hand an "International Directory of Zoologists." This will include zoologists, collectors, draughtsmen, preparers, modellers, and dealers, and will be compiled by Professors F. E. Schulze of Berlin, and H. Ludwig of Bonn. They will be glad to receive names, which should be sent at once.

# NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

THE following appointments among Botanists have recently been made:—Dr. Hans Molisch to the Professorship at Prague vacant through the death of Dr. Weiss: Dr. L. Tost to be extraordinary Professor in the University of Strassburg; Arturo Baldini to be Curator of the Botanical Gardens at Bologna; Dr. Fr. Schult to be extraordinary Professor in Kiel University; Mr. M. A. Carleton, lately assistant in the Agricultural College at Manhattan, Kansas, to be assistant in the Division of Plant Pathology at Washington, D.C., where he will pay special attention to the rusts of cereals and other plants; and Mr. J. Percival, who has for the last few years been lecturing on subjects of agricultural interest for the Surrey County Council, to be Professor of Botany in the new Kent and Surrey Agricultural College at Wye. We also note that Professor Julius Wiesner has returned from his travels in Java.

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THE United States Government have appointed Mr. F. L. Scribner, recently director of the Tennessee Agricultural Experiment Station, to a newly-created post chiefly connected with the investigation of grasses and forage plants. Such an official is an admirable invention; but why should he be handicapped at the outset by being labelled "Agrostologist"?

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DR. KUMM has been appointed Curator of the natural history collections in the West Prussian Provincial Museum at Dantzig.

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AMONG the names of those nominated by the Council of the Royal Society for election we notice those of Mr. W. Bateson, Mr. G. A. Boulenger, Mr. R. Lydekker, and Dr. D. H. Scott. It is not likely that anyone whose opinion is worth having will cavil at this year's selection. Still we cannot help regretting that no geologist has been nominated.

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MR. CHARLES BARON CLARKE has been selected for the new President of the Linnean Society in succession to Professor Charles Stewart. A more satisfactory selection could scarcely have been made.

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THE ruling of the Chairman that Mr. Thiselton Dyer's motion expressing approval of the Gresham scheme was out of order, has probably saved the Convocation of the London University from making a sad exhibition of business incompetence. At the previous meeting, Convocation carried a resolution referring the whole question of the constitution of the University to a joint committee representing both the Senate and Convocation. This proposal has been accepted by the Senate, and the Committee has been appointed. Mr. Thiselton Dyer's resolution simply re-opened the whole question before the Committee's report had been received. This course would have been disrespectful to its own committee, and practically a breach of faith with the Senate. The main result of this precipitate haste would have been to alienate many votes that would have been given for the resolution had it come on before the appointment of the Committee, or would be after the report is received. In the present condition of politics, no immediate steps are likely to be

taken by the Government in giving effect to the recommendations of the Gresham Committee; so that the delay can do no harm, especially as the matter is mainly one of detail; for both sides agree that a single teaching university for London is the one thing needed.

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A MUNIFICENT benefactor, this time a private individual, has been found for University College, Liverpool, in the person of Lord Derby, who has given £10,000 to endow a Chair of Anatomy.

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THE sum of £1,000 has been placed by the Goldsmiths' Company at the disposal of the governing body of the Imperial Institute for fitting up and equipping a department of scientific and practical research. This will deal with the investigation and practical valuation of new and little-known natural products received from India and from the colonies composing the Empire. We understand that this extension of the Institute's activity will not be allowed to interfere with the social evenings and smoking concerts, or with the special "grand illumination" of the galleries every night.

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ANOTHER City company, the Grocers', has offered three research scholarships, value £250 each, open only to British subjects, as an encouragement to the making of exact researches into the causes and prevention of important diseases. Meanwhile Chelsea and Victoria Street send out their protest, and the Russian moujik naturally believes that cholera is exported to him from England.

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AT Oxford, Congregation has unanimously passed the resolution: "That it is expedient to establish new degrees, to be granted after a course of special study or research, to members of the University who have passed the examinations qualifying for the degree of B.A., and to persons not being graduates of Oxford who have given satisfactory proof of general education and of fitness to enter upon a course of special study." What these degrees shall be entitled is not yet decided, nor does it much matter; to have the degrees at all is a great point gained.

---

A STATION for the investigation of marine zoology and botany is being founded at Cumbrae, under the personal supervision of Mr. David Robertson, "the naturalist of Cumbrae."

---

MR. THOMAS BROCK, R.A., has finished his sketch—model for a statue of the late Sir Richard Owen—which is to be placed in the Natural History Museum. The statue will represent Owen in his robes as Hunterian Professor of the Royal College of Surgeons, and a representation of a bone of *Dinornis* will be placed in his hand to commemorate one of his most remarkable successes.

---

THE anniversary meeting of the Royal Geographical Society will be held on the 28th of May. The only important changes of Council expected will be the election of Major Leonard Darwin as secretary, in the room of Mr. D. W. Freshfield, and Sir John Kirk as foreign secretary, to replace the late General Sir C. P. Beauchamp Walker. The Society's awards have been distributed as follow:—The Founders' Medal to Captain H. Bower, for his remarkable journey across Tibet; the Patrons' Medal to Elisée Reclus, for his valuable service to geography, chiefly by the publication of his "Nouvelle Géographie Universelle," in 21 volumes; the Murchison Grant to Captain Joseph Wiggins, for his work in the waters of Northern Siberia; the Back Grant to Captain H. J. Snow, for his maps of the Kuriles; the Gill Memorial to G. E. Ferguson, for survey work on the West Coast of Africa; and the Cuthbert Peek Grant to Dr. J. W. Gregory, for his journey and observations in the Baringo and Mount Kenia district.

---

AT the annual general meeting of the British Ornithologists' Union, held on May 9, Lord Lilford was re-elected President. The report of the Council gave a

flourishing account of the finances. It was agreed that a new (seventh) series of the "Ibis" should be commenced in 1895, with the thirty-seventh volume, and that Dr. Sclater and Mr. Howard Saunders should be appointed joint editors.

---

THE scientific women of America have formed themselves into a National Science Club, of which Mrs. Ada D. Davidson, who was in evidence at the World's Fair (NATURAL SCIENCE, vol. iii., p. 341), is president. At the annual meeting recently held in the hall of the National Museum, Washington, she gave an address and read a paper on Trilobites. Further lectures will be given in the same place, under the auspices of the Science Club.

---

LETTERS have recently been received from Mr. Scott Elliott, who writes from the west of the Nyanza, and is probably by this time in Ruwenzori. He had crossed the Kagira River, so that he apparently intends to keep well to the south of Bunyoro and the country raided by Kaba Rega. The fighting with this potentate is really all in Mr. Scott Elliott's favour, as it will keep Kaba Rega too much employed to be able to raid to the south. The re-establishment of a station in Soru will also aid, and appears to be a confession of the great mistake committed by Sir Gerald Portal in reversing Captain Lugard's policy. Further news regarding the fate of Prince Eugenio Ruspoli, the son of the Syndic of Rome, has come to hand, and confirms the story of his having been killed by an elephant. The accident happened in the valley of the Omo, one of the two rivers that flow into the north end of Lake Rudolph, so that Prince Ruspoli had got further into one of the most interesting countries in Africa than any previous explorer. If adequate observations have been taken and maps prepared, Prince Ruspoli's life will not have been spent in vain. Another expedition is just starting for this district, under command of Dr. Donaldson Smith, of Philadelphia, accompanied by Mr. F. Gillat and a well-trained zoological collector. The expedition will start from Bulhar, on the Somali coast, cross the Haud to Milmil, and thence strike through the Galla country to the north end of Lakes Rudolph and Stephanie. The expedition will be so powerfully equipped that it need have little to fear from opposition by the natives. It ought to yield rich results to science. It is understood that Dr. J. W. Gregory would have accompanied the expedition had his health permitted. Mr. Coryndon, of the black "White Rhinoceros" fame, is now well on his way to his collecting camp somewhere between the north end of Lake Tanganyika and the eastern margin of the great forests of the Upper Congo.

---

A STEREOSCOPIC photomicrograph of the diatoms *Heliopelta* and *Coscinodiscus* forms a frontispiece to the fourteenth volume of the *American Monthly Microscopical Journal*. These pictures, which are taken by Dr. W. C. Borden, of Newport, R.I., are intended to show the superiority of stereoscopic as opposed to ordinary photomicrographs for the representation of certain microscopic objects. In the same number of the journal (vol. xiv., no. 12), Mr. K. M. Cunningham calls attention to a remarkable collection of photomicrographs, formed by Dr. Henderson, of Mobile, between the years 1860 and 1870. Most of these were taken on wet, or collodion, plates, with Dr. Herapath's ¼-inch lens, "Ross," and, after 30 years, the silver prints are, in some cases, perfectly preserved. It is to be remembered, as Mr. Cunningham points out, that these photomicrographs must have been taken by sunlight, and not with the approved methods furnished by the electric light or lamp.

---

WE regret to have to record the deaths of Dr. Joseph von Szabo, of Budapest, which occurred on the 10th April last; of the veteran geologist, August von Klipstein, who died at Giessen on 16th April, aged 93 years; and of Dr. J. Schmalhausen, the Professor of Botany at Kieff.

# CORRESPONDENCE.

THE THREEFOLD DIVISION OF THE DRIFT.

IN the appreciative review of the late Professor Carvill Lewis's Glacial Geology of Great Britain and Ireland, which appeared in your May number, Professor Lewis is credited with removing, among other stumbling blocks, that of the supposed threefold division of the drift. "He showed that the old view of the threefold classification of the drift into an upper and a lower boulder clay, separated by sands, is absolutely untenable; that even within very short distances this supposed sequence is often reversed, and we may get the boulder clay in the middle, with sands above and below."

Will you permit me to point out that from a very early period of my study of the drift, my observations led me to doubt the correctness of such a classification. In all the Glacial papers published by me since 1873, and they have been pretty numerous, I have contended for the unity of the Glacial Period in Britain, and have stated again and again that the so-called Lower Boulder Clay, Middle Sands and Gravel, and Upper Boulder Clay do not represent two Glacial Periods, divided by an inter-Glacial Period, but are continuous deposits. The arguments quoted from Professor Lewis are such as I have frequently used, and that at a time when I was practically alone in my opinion. Professor Lewis told me personally that he agreed with many of my glacial views, and the evidences of the fact can be seen in the book itself.

It follows from this that there is a possibility, however remote, of an "orthodox" geologist being right, though he may think there is something still to be said in favour of submergence.

Allow me to add that I have read the work of Professor Lewis, whom I held in esteem, with great interest, and think that his field notes and elucidatory remarks are of very great value, showing extensive and accurate observation put into a form that can be used by any competent geologist, whatever may be his views. What is still more rare, they exhibit an open and truthful mind, that does not blink facts, whichever way they may seem to tend.

Park Corner, Blundellsands. T. MELLARD READE.

*May* 1, 1894.

---

MR. WILLIAM TAYLOR (Llanbryde, Elgin) writes deprecating the tone of our review of Mr. E. T. Newton's memoir on the Fossil Reptiles of the Elgin Sandstones (*suprà*, p. 305). He remarks that the Naturalists of Elgin are grateful to Mr. Newton and the Geological Survey for the labour they have bestowed upon the subject, and points out that no unconformity has yet been discovered between the reptiliferous beds and those containing Palæozoic fishes. He asks, "might not *Elginia* and *Gordonia* be Permian?" He then comments upon the lamentably frequent tendency of professionals to ignore the work of local observers, and adds: "We cannot help pointing out that Patrick Duff, of Elgin, was right about the Parallel Roads of Glenroy, while Darwin was wrong. Duff was right in saying that *Dendrodus* was the tooth of *Holoptychius*, and Owen was wrong. Professor Judd said that fossil reptiles would not be found south of a certain line of fault: Dr. Gordon, of Elgin, declared they would be so found, and he has proved to be correct."

---

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III. Recent Researches on the Fauna and Flora of Madagascar. By C. Davies Sherborn, F.G.S.
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VI Biological Theories. VI. The Phylogeny of Lucernarians. By C. Herbert Hurst, Ph.D.
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